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Sustainable Energy Action Plan fot the City of Mtskheta

September, 2016

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Abbreviations

BC	Before Christ
GEL	Georgian Lari
CoM	Covenant of Mayors
GHG	Greenhouse gas
GPG	Good Practice Guideline
SEAP	Sustainable Energy Action Plan
CO_2	Carbon Dioxide
LED	Light- emitting Diode
BAU	Business-As-Usual
MIA	Ministry of Internal Affairs
LLC	Limited Liability Company (Ltd)
MWh	Megawatt hour (10^3 KWh)
Ltd	Limited Liability Company
W	Watt
CH_4	Methane
yr	year
LEPL	Legal Entity of Public Low
GWh	Gigawatt hour (10^9Wh=10^6KWh)
IPCC	Intergovernmental Panel on Climate Change
C	Carbon
UNFCCC	United Nations Framework Convention on Climate Change
SHW	Solid Household Waste
DOC	Degradable Organic Carbon
BOD	Biochemical oxygen Demand
COD	Chemical oxygen Demand
MCF	Methane Correction Factor
EC-LEDS	Enhancing Capacity for Low Emission Development Strategies
USAID	United States Agency for International Development
GIZ	German Society for International Cooperation
EU	European Union
GEF	Global Environment Facility

1 Introduction

Mtskheta with its surroundings is one of the ancient settlements on the territory of Georgia. For over 800 years, in the 1st millennium B.C., Mtskheta represented political, economic and religious center of the Kingdom of Iberia. Mtskheta with its surroundings is rich in historical monuments and archaeological findings. Over this territory, there are more than 200 cultural monuments.

In early feudal age an intensive construction of cult premises was going on in Mtskheta – Svetitskhoveli (IV century - wooden church, V century - stone basilica), Samtavro St. Nino Church (IV century, restored in XIX century), Minor Jvari Church (II half of VI century), and Big Cathedral (585/586 – 604), Antioch (VII-VIII cc), etc. In the period of advanced feudalism big temples had been constructed – Svetitskhoveli (1010-1029), Samtavro (30s of XI century), Barbareti (X-XI cc), Holy Mother's Church (XI-XII cc), St. George's Church of Kaloubani (XII century), etc.

Archaeological excavations on the territory of Mtskheta were launched in the early XX century. From 1930s the Samtavro Valley was declared an archaeological and architectural reserved area. The same status was obtained by the surrounding area of Armazi from 1940s, and old Mtskheta territory between the Rivers Mtkvari and Aragvi up to Bebristsikhe - in 1957. Since 1968, Mtskheta was declared as a Town-Museum. In 1994, the UNESCO included the town of Mtskheta and Svetitskhoveli Cathedral in its list of world's cultural heritage.

Town of Mtskheta lies at the confluence of the Rivers Mtkvari and Aragvi, on both banks of the River Mtkvari and on the right bank of the River Aragvi, on Tbilisi-Samtredia line of the Railway Station. It is located at 480m above sea level and in 21km distance (through railway) from Tbilisi.

The climate of Mtskheta is temperate humid subtropical (average annual temperature is 10.8^{0}C, in January – 1.1^{0}C, in July – 22.1^{0}C). In Mtskheta winter is cold (absolute minimum - 29^{0}C), and summer is hot (absolute maximum 39^{0}C). Precipitation – 590mm per year.[1]

On June 15, 2014, local self-government elections were held, as result of which town of Mtskheta became a self-governing city for the first time in its history. According to of 2015 data, the population of town Mtskheta makes 9 800 people.

Economy

From the very beginning, it should be noted that it is only two years that Mtskheta has become a self-governing entity, and there is only scarce statistical information about the town itself and, consequently, it is difficult to conduct the detailed analysis of the town's economic activities, or its future outlook.

Despite the fact that in this direction a special survey has not been conducted yet, it could be said that tourism is the leading and thriving economic field for town of Mtskheta. Accordingly, the sustainable development perspective should also be discussed in the context of tourism.

Starting from 2012, including 2015 the number of tourists is growing steadily. The graph on Fig. 1 shows the number of those tourists who visited the Mtskheta Tourism Information Center and accordingly were registered there; however, the number of tourists arrived in the city is much higher.[2]

[1] https://ka.wikipedia.org (according to nearest weather station "Mukhrani"). Correction for global warming: present value of annual temperature 11.5 ^{0}C, annual precipitation 584 mm.

[2] We should not forget the fact that only a certain number of tourists use the Tourism Information Center service, consequently, the actual number of tourists arrived in town of Mtskheta is much higher than the statistics given in Figure 1. According to the same Tourism Information Center, in 2012 about 90 000 tourists visited Mtskheta, in 2013 – 100 000 tourists, and in 2014 and 2015 – 110 000 and 130 000 tourists respectively. This amount of tourists

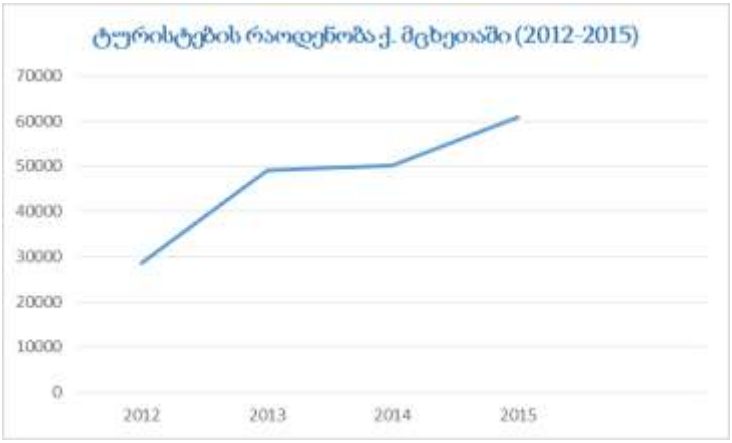

Fig. 1. Number of Tourists Registered at Mtskheta Tourism Information Center, 2012-2015.

The majority of tourists registered at Mtskheta Tourism Information Center are foreigners; partially this is stipulated due to the fact that Georgian tourists rarely address the information center for service. Especially growing number comes on tourists from Ukraine, Poland, Germany, Israel, USA and Russia.

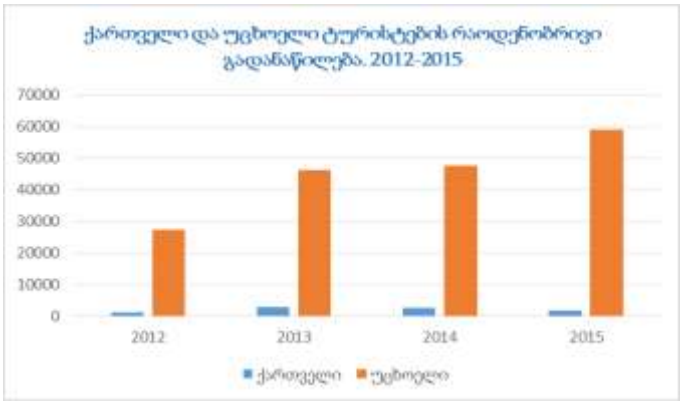

Fig. 2. Quantitative Distribution of Georgian and Foreign Tourists Registered at Mtskheta Tourism Information Center, 2012-2015

The number of foreign tourists is significant and noteworthy due to the fact that potentially they are the consumers for local services (hotels, tours, souvenirs, local cuisine, etc.), and, consequently, their share in dynamics of Mtskheta incomes is apparently higher than that of local tourists. However, for enforcing this assumption, it is needed to conduct special studies within the frames of which will be assessed more accurately the share of tourism in growth of gross domestic product (GDP) of town Mtskheta.

Local budget

According to the classification of budget expenses and non-financial assets growth of Mtskheta Municipality[3] in such sectors as environment protection, transport and road infrastructure, waste collection and recycling, etc., the tendency of growth of allocated financial resources is noted. In the Table below several examples are shown to better demonstrate the above-said:

includes both the tourists registered by the Information Center and those who weren't registered (especially the local tourists and pilgrims).

[3] https://matsne.gov.ge/ka/document/download/3362513/0/ge/pdf

Table 1. Functional Distribution of Mtskheta Municipality Budget Expenses and Non-financial Assets Growth for 2014, 2015 and 2016

Sector	Actual 2014 (GEL)	Plan 2015 (GEL)	Program 2016 (GEL)
Transport	886 000	5 900	83 100
Motor transport and roads	886 000	5 900	83 100
Environment protection	0	31 000	2 198 500
Housing and communal services	323 300	456 500	1 359 800
Apartment construction	48 400	296 200	142 900
Water supply	0	0	1 089 800
Waste collection, treatment and disposal	0	0	2 136 300
Wastewater management	0	31 000	62 000

According to the presented Table, in 2016 the Municipality will direct significant financial resources towards development and arrangement of Transport Sector and motorways, environment protection, among them waste management, housing and communal services, and water supply system.

Development Plans

As it was mentioned above, town of Mtskheta was granted the status of a self-governing city in compliance with the new law of self-government, adopted by Georgian Parliament.[4] Granting the status of a self-governing city means significant changes in terms of the city's governance form, its rights and obligations, and its mandate. The municipal government unit is given an opportunity to become more independent from central government in the decision-making process and plan and develop the city within the frames of its own capacity, which is also accompanied with increasing responsibility both in front of the city population and the country as well.

Along with obtaining the status of a self-governing city, on May 11, 2015 town of Mtskheta became the signatory city to the Covenant of Mayors (CoM), which means undertaking voluntary commitment under this agreement - to prepare and implement Sustainable Energy Action Plan (SEAP) aiming to reduce the GHG emissions from its territory by at least 20% to 2020.[5]

Parallel to preparation of the SEAP, the City Hall has also started working on drafting General Development Plan for Mtskheta.

[4] https://matsne.gov.ge/ka/document/view/2244429
[5] http://www.covenantofmayors.eu/about/signatories_en.html?city_id=4592

2 The Energy Sustainable Development Strategy

The Sustainable Energy Action Plan (SEAP) for Mtskheta covers Transport, Buildings, Public Lighting, Waste and Greening Sectors. Presumably, this plan will become the ground for Mtskheta Development Strategic Plan, which has not been drafted yet for the city, as Mtskheta became a self-governing city just recently, in 2014. At the same time, as it was mentioned in the introduction, the city is included in the list of the UNESCO World Cultural Heritage that sets certain restrictions to the development of the city and in this process the concept of "Sustainable Development" assumes some special importance.

This version of the SEAP has been prepared in 2016 but 2014 is taken as base year when the city has become self-governing and after which Mtskheta signed Covenant of Mayors. For implementing the presented plan before 2020, the city has 6 years that is a short period to complete the obligation which other cities had also undertaken, but they had signed the Agreement earlier and they had more time for the realization of their plan. Consequently, during execution of this Action Plan it should be considered that due to short period left until 2020, city Mtskheta might not be able to reach reduction of emissions by 20% for that time. In this case, consequently, the benchmark for reaching this goal will be moved up to 2025 and presumably, Mtskheta will join the renewed version of Covenant of Mayors, which lasts until 2030 and additionally considers the adaptation measures.

Coming out of the above-mentioned, the emissions reduction strategy for the main sectors discussed in the Action Plan (Buildings, Transport) has been defined by two periods: short-run period (2015-2020) and long-run period (2020-2025). The measures planned for the short-run period are more concrete and detailed, and the measures planned for long-run period are discussed in strategic view and require additional study, planning and technical and economic justification. Such an approach is in full compliance with the methodology used for developing Sustainable Energy Action Plan.

Based on the emissions inventory for Base Year 2014 and CO_2 emission growth rate by 2020, the GHG emissions reduction sectoral strategy has been developed for all the sectors discussed within the frames of the SEAP for Mtskheta and the main directions were outlined. At this stage, among the sectors the top priority is given to Waste and Wastewater Sectors followed by Buildings and Public Lighting Sectors.

Solid Waste and Wastewater Management Sector

The Solid Household Waste Sector in Mtskheta is a rapidly growing sector that is directly connected with tourism growth. For the last four years, in 2012-2015, amount of the waste in Mtskheta has increased by 45%, and by 2020 it is expected to grow by 23%. The landfill where Mtskheta delivers its residential waste is not disposed on the territory of city Mtskheta and belongs to the Solid Waste Management Company. Consequently, Mtskheta City Hall does not have any direct touch with this sector and cannot implement measures related to landfill. Hence, at this stage, within the frames of this Action Plan, the City Hall planned to implement paper and plastic waste separation measure that accordingly will reduce methane emission at the landfill.

City of Mtskheta does not have any well-arranged sewerage system and, accordingly, the wastewater is not treated, so the priority for the City Hall in the short-run perspective is also wastewater collection and arrangement of its treatment facility that on its side will require utilization or flaring of methane generated at this location. In case of Mtskheta, due to the small amount of methane generated, it is more expedient to conduct its flaring at the spot that may be implemented only after installation of treatment equipment (after 2020).

Buildings Sector

The second important sector in Mtskheta SEAP is Buildings Sector.

Inventory of emissions from Buildings Sector demonstrates that the 84% of the GHG emissions from Mtskheta buildings is emitted from residential houses. Thus, to achieve the 20% benchmark of emissions reduction it is urgently necessary to work out the programs for residential and private (private guest) houses sector, supporting the introduction of special energy efficiency and renewable energy measures in this sector. At the same time, it should be considered that the energy consumption in Mtskheta is low as it is in other cities of Georgia, as the buildings are not heated utterly and significant part of population is living in the conditions of energy poverty. Accordingly, programs for residential sector require solid preparatory activities including the search of donors for outside financing, specification of legislative basis and regulations to enable the Municipality to operate directly with the population and provide a support to them. Mtskheta City Hall takes into consideration that in the remaining 4 years till 2020 it may be impossible to implement all these programs with full capacity. In this case reaching the target indices on the reduction of emissions could be postponed till 2025.

In the 6 years' period in between the base year 2014 and 2020, the Mtskheta City Hall strategy foresees providing maximum support to the use of energy saving and renewable energies in municipal buildings to demonstrate their advantages for population and other commercial buildings. In addition to this, the popularization and facilitation of energy saving measures is planned for residential buildings, which are relatively more organized and are engaged in the City Hall co-financing programs. To such buildings belong the dwellers cooperatives in the buildings.

At the same time, to achieve the emissions reduction targets it is highly valuable to conduct the energy efficiency and renewable energy introduction measures in private houses as well. The City Hall will elaborate specific programs and approaches for this task and will actively collaborate with state structures, as well as, with different funds and private organizations.

According to the SEAP strategy, in the Buildings Sector of city Mtskheta mainly the following measures will be implemented until 2020:

In the municipal buildings:

1. Thermal insulation of attics in all municipal buildings;
2. Maximal transferring the lighting systems to the LED bulbs in kindergartens;
3. Application of solar collectors in day nurseries.

In the residential sector in a short-run perspective, the City Hall will collaborate with the apartment-owners cooperatives for adoption of following measures:

1. Popularization of the use of the LED bulbs;
2. Thermal insulation of common places in apartment buildings.

In a long-run perspective, the Municipality will work out programs and financial schemes to collaborate with the owners of private houses, especially, with the owners of guest houses, in introducing the following types of activities:

1. Facilitating in private guest houses such energy efficiency measures as thermal insulation of roofs and decrease in infiltration;
2. Preparing the programs for promotion of renewable energy sources (solar collectors) and their implementation in guest houses;
3. Facilitating in private houses such energy efficiency measures as thermal insulation of roofs and decrease in infiltration;
4. Promoting application of renewable energy sources (solar collectors) in residential houses;
5. Establishing of building standards (in cooperation with the Ministry of Economy and Sustainable Development of Georgia) appropriate to Mtskheta Region's climate conditions and rising awareness of general population and construction organizations on energy efficient construction.

Public Lighting Sector

Public Lighting Sector also represents a priority sector for Mtskheta as a tourist city. Coming out of its specific character, it is natural that the town consumes a rather big amount of energy in Public Lighting and in the short-run perspective it is planned to ensure supplying the entire city with electricity, as well as, to transfer the entire grid on energy efficient LED bulbs and installation of the Lighting Control System that will reduce by 84% the forecasted energy consumption in this sector of town by 2020. Besides reduction of emissions, the mentioned measure will bring significant financial savings to the City Hall. The saved finances will be directed towards implementation of other energy efficient and greening measures. In longer-run perspective, the city is planning to transfer the grid to automatic operation that will bring the City Hall some more additional savings.

Transport Sector

In Transport Sector, several strategic measures are planned to be implemented. They are:

- Constructing a new bridge across the River Mtkvari (the length will be about 150m) that will allow reducing within the territory of Mtskheta the flow/transport driving of local residents by 40% and tourists by 30%, and create an additional parking area;
- Construction of another smaller pedestrian bridge across the River Mtkvari for tourists and pilgrims. This bridge will reduce travelling of tourists and pilgrims by vehicles on the territory of the city and create an additional territory for parking at the Mtkvari embankment;
- Improving municipal public transport service and comfort, and transferring to ecologically clean transportation;
- Working out parking policy on the territory of the city;
- Facilitating pedestrians and cycling transport travel;
- Improving the quality of motor roads.

In short-term perspective (2015 - 2020) the city plans to make the parking policy stricter, rehabilitate road infrastructure, and set up municipal transport which will serve the city with well-planned routs and comfortable buses operating on clean fuel. It is considered that these buses will create an efficient alternative to the travel on long distances by private vehicles, and will serve both tourists and local population. The arrangement of transfer stations is also planned to promote the transfer of passengers from intercity lines to inner city routs.

Besides, in the nearest future the Mtskheta City Hall plans to develop stricter parking strategy, which will limit traveling by vehicles through the town. However, the City Hall will provide all the arrivals with parking area. The responsibility for arrangement of parking infrastructure and parking fee collection will be imposed on the municipal enterprise, which will be established for administration of public transport. This will enable the use of the parking revenues for improving and subsidizing the public transportation.

Additionally, in the short-run perspective facilitation of pedestrian and cycling travel is planned being the healthier alternative to traveling by taxi or private car on short distances. As Mtskheta landscape is hilly to certain extent, the adoption of cycling traveling practice may face some difficulties, so it is considered to import mopeds for local population and electric bikes for tourists to travel in the city.

In long-run perspective, after 2020, the strategic vision of Mtskheta Transport Sector includes construction of two new bridges that will significantly reduce the number of vehicle traveling through the city and create additional parking territories.

Greening Sector

The green cover of Mtskheta is 257.6ha making 4.0% of the entire city territory. Green cover includes recreation zones, private gardens, and all kinds of greening. The recreation zone of the city is in rather acceptable condition and does not experience any special degradation. Despite of this fact, implementing greening measures of the town is important not only in terms of increasing the source of carbon dioxide sequestration but also for improving generally the living, recreation and tourist conditions.

It is planned to establish a new tourist-recreation zone in town at 40ha area, of which 20ha will be forest-park. As a result of the measure, the removal of CO_2 from on the territory of Mtskheta will grow by 8%.

The Energy Sustainable Development Strategy for the City of Mtskheta

The methodology to work out the Sustainable Energy Action plan for the City of Mtskheta does not imply the use of the base year, which can create obstacles for the city development process and may hamper the city to fulfill its commitments. The methodology used in the presented document provides envisaging the development perspective of the country and the selected city, as well as, inevitable growth of emissions by 2020 (resulting from the increased demand on energy carriers). This increase is considered in the BAU scenario, in comparison to which the reduction of emissions is evaluated as a sequel of implementation of different measures and project proposals. The methodology for the development of the BAU scenario is discussed in more detail in the Appendix I.

Energy Sustainable Development Strategy for the City of Mtskheta considers the function of Mtskheta as tourism center and is focused on energy efficient development of tourism infrastructure and growth of energy efficiency and utmost consumption of renewable energies in tourism service sectors that is described accordingly in the Action Plan priorities.

In the two Tables below the summarized results of GHG inventory for 2014 and 2020 are given along with the evaluation of emissions saved in result of measures considered in SEAP.

Table 2. Emissions of GHGs in Mtskheta in 2014 and 2020 (tCO2 eq.)

Sector	2014	2020 (BAU)	Growth (%)
Waste Management	1 450	2 220	53
Public Lighting	100	120	20
Buildings	6 800	9 200	35
Transport	8 716	12 228	40
Total	**17 066**	**23 768**	**39**

Table 3. Emissions Saving according to Mtskheta SEAP

	Saving (tCO_2 eq.)	Share of Sector in total Saving (%)	Saving in the Sector Itself by 2014 (%)	Saving in the Sector Itself by 2020 (%)
Waste	24	0.4	2	1
Public Lighting	101	1.2	101	84
Buildings	1 757	20.0	26	19

Transport	6 730	76.0	77	55
Greening	201	2.4		
Total	**8 813**	**100.0**	**52**	**37**

Table 3 shows that the biggest potential to save emissions in terms of percentage is in Public Lighting Sector (84%), on the second place is Transport Sector with 55%, which is followed by Buildings Sector with 19%.

The same Table shows that the share of Transport Sector in total savings (76%) is the highest and it is followed by Buildings Sector with 20%.

Fig. 3 shows distribution of sectoral emissions between 2014 Base Year and 2020 according to BAU scenario, and other figures (Fig. 4 and Fig. 5) demonstrate increase of emissions in different sectors according to BAU and SEAP scenarios.

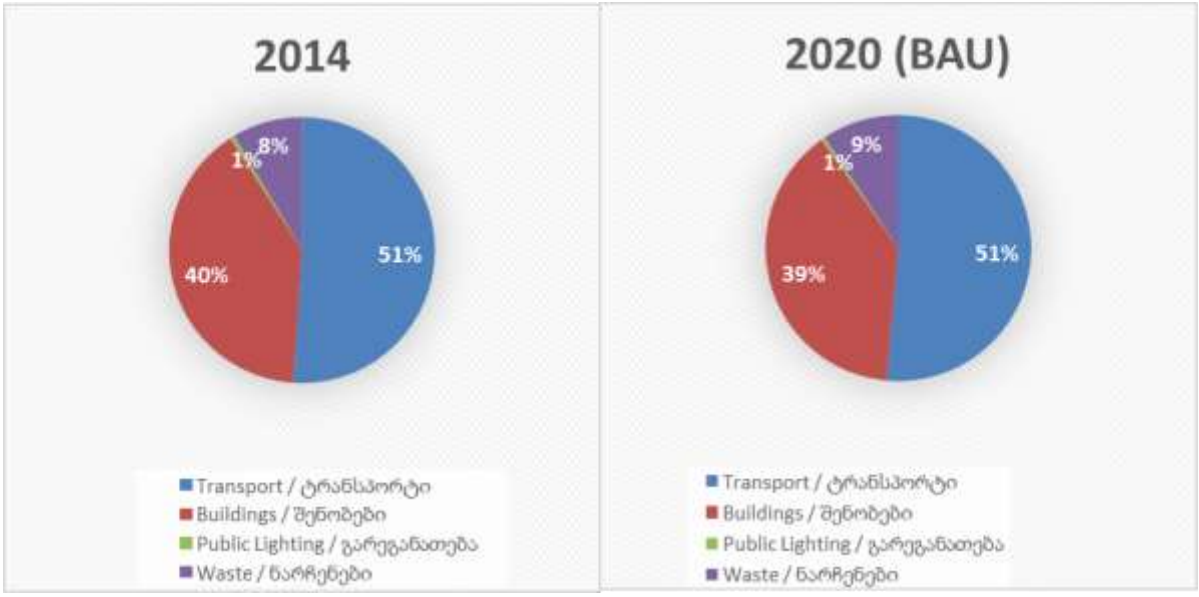

Fig. 3. Distribution of Sectoral Emissions between 2014 and 2020

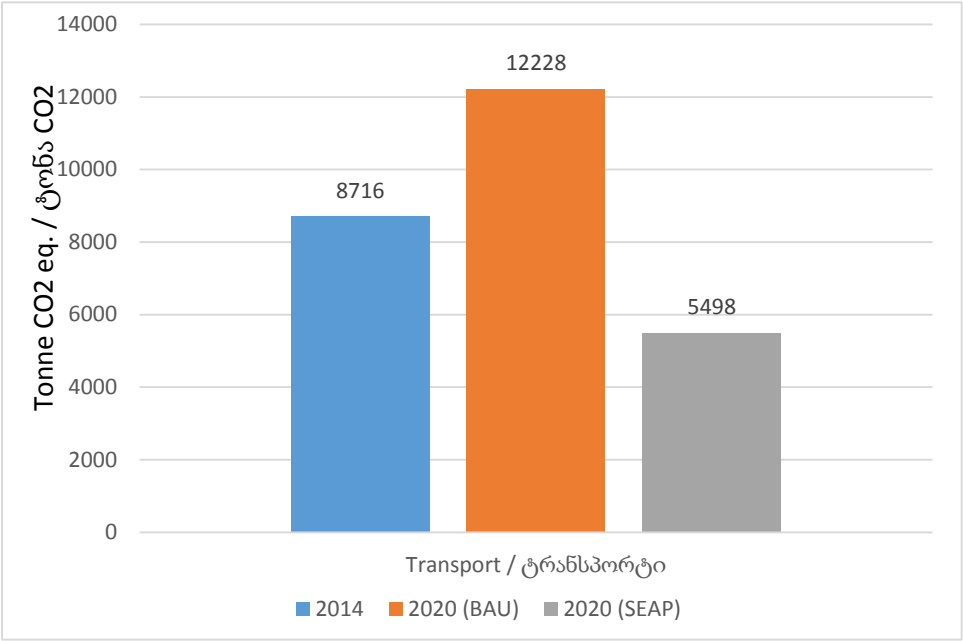

Fig. 4. Growth of Emissions according to BAU and SEAP Scenarios in Transport Sector

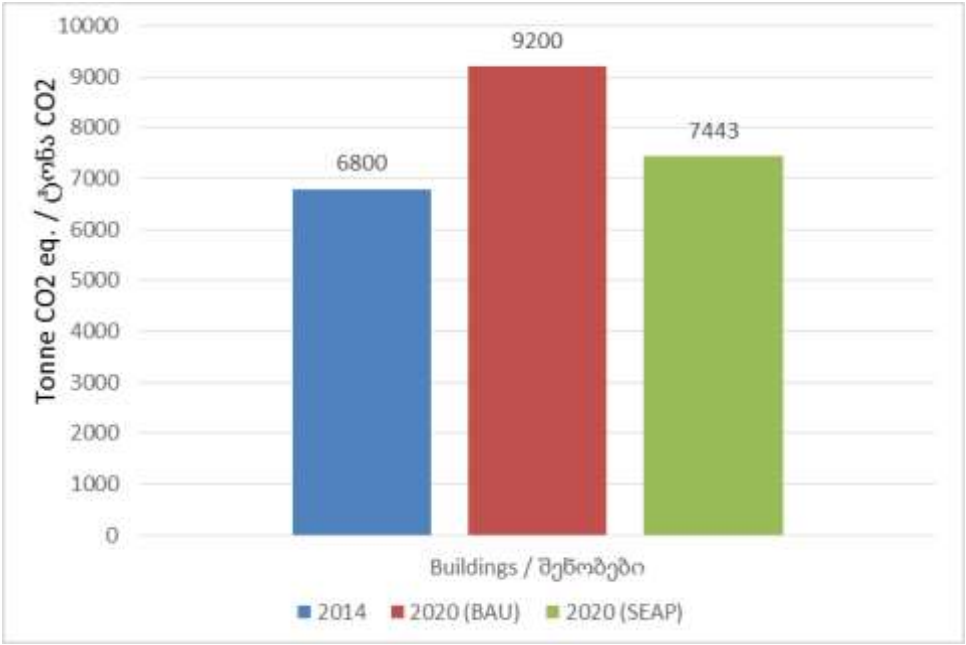

Fig. 5. Growth of Emissions according to BAU and SEAP Scenarios in Buildings Sector

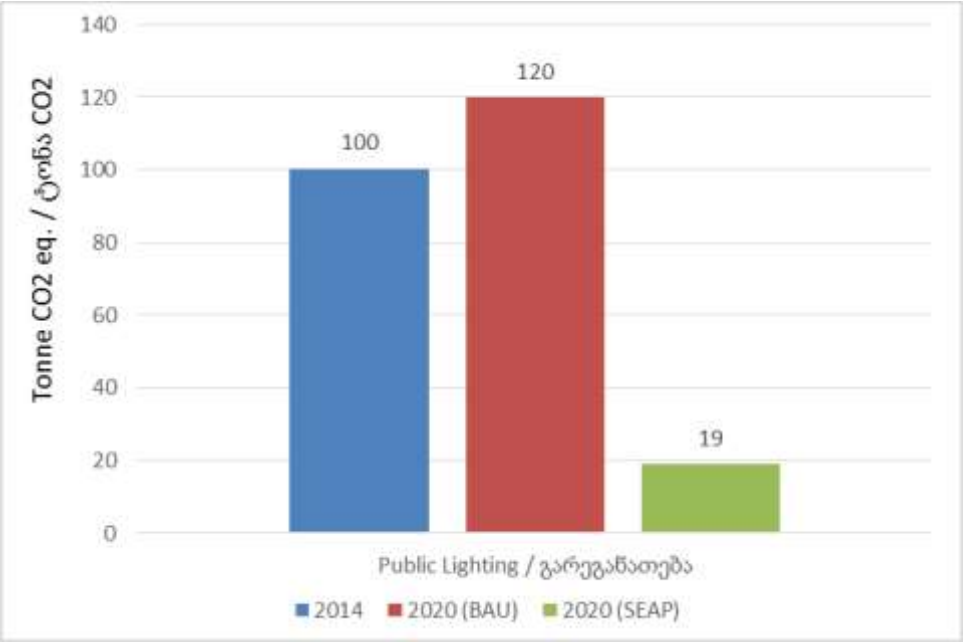

Fig. 6. Growth of Emissions according to BAU and SEAP Scenarios in Public Lighting Sector

3 Transport

3.1 Overview of the Sector

City of Mtskheta is the administrative, economic, political and cultural center of Mtskheta-Mtianeti Region.

Total area of City Mtskheta is 43, 93 km^2. In total, there are 50 streets and 8 blind lanes in the city. The total length of the streets makes up 100km. The length of the central street is 8km (Narekvavi – Mtskheta – Railway Station).

City of Mtskheta has a bypass road and the transit transport almost does not ride through the city territory. Daily, on the average, 4 600 vehicles ride through the territory of the city, of which 1 500 units are private vehicles owned by local residents of city Mtskheta, about 3 000 units of transport enter from outside the city in the form of tourist flow (among them minibuses, taxis, private vehicles, distribution vehicles). According to the information of Mtskheta Municipality, in 2014, 1500 private motor cars, 20 units of municipality service vehicles, 41 vehicles serving different organizations (motor cars), 18 trucks and heavy weight transport moved locally in Mtskheta. The number of vehicles riding through the territory of Mtskheta is given in Table 5[6].

Considering the tourism potential of the region and the disposition of the city, the role of town of Mtskheta, as a tourist city, is significant in the whole region. Town of Mtskheta is one of the central tourist locations for all tourists arrived in Georgia that stipulates entering the city's territory additional transportation means[7].

[6] The statistics given in the Table is provided by a local expert, calculated and assessed through a survey conducted by him as official statistics for Transport Sector of the City Mtskheta can't be obtained for the moment. According to the reference of Mtskheta Regional Administration, the Mtskheta Regional Administration does not have any information on the motor transport registered in Mtskheta, as well as, according to the reference of Mtskheta-Mtianeti Regional Main Division of Patrol Police Department of MIA, the mentioned information is beyond the competence of this Division.

[7] Tourist routes are carried out not only by foreign but by local, Georgian tourists and pilgrims.

On the territory of the city, three gas filling stations (Rompetrol, Wissol, Lukoil) are located. At each gas filling stations 12 tons of diesel and 9 tons of gasoline are sold daily, i.e. 4380 tons of diesel and 3285 tons of gasoline is sold per year.

The main part of Mtskheta population travel in the city either by local municipal transport, or private vehicles or by foot. The municipal transport passes 8km section of the central street of the city from Narekvavi up to Railway Station (up to the Mtskheta 12 Apostles Orthodox Secondary School) that takes 35-40 minutes' drive. The cost of transportation is 0.40 GEL. The municipal transport works from 08:00am to 6:00pm. For the moment, the inner municipal transport consists of 8 minibuses (Ford and Mercedes brand, manufactured in the 90ies).

On the territory of the city, intercity (Mtskheta-Tbilisi) minibuses are operating along with those riding from the city to the Municipality villages. The intercity (Mtskheta-Tbilisi) transport passes a 8km section of Mtskheta central road and then it goes to Tbilisi. The minibuses Mtskheta-Tbilisi depart every 15 minutes (the total number of minibuses is 22, of which daily operate 6 minibuses (mostly Ford and Mercedes brand minibuses).

Tourists mostly travel by taxis driving on the territory of the city. For the moment, 27 private taxis serve the city.

The city self-government is served by 20 vehicles.

On the territory of the city distribution vehicles ride every day (mostly, shuttle mini-transport, refrigerators, etc.).

Arranging the streets of the city (damaged asphalt rehabilitation works) and adding more bus stop booths (4 units) are planned for current year 2016.

According to information provided by the Infrastructure Development, Spatial Arrangement, Architecture and Construction Service, in 2012-2014, within the entire Municipality 15km road was asphalted and arranged, in 2015– additionally 5km, and in 2016 – 10km road was paved with asphalt.

Coming out of the tourism potential of the city, the role of Mtskheta is huge in tourism development in the region, requiring from the Mtskheta City Hall maximum unloading of the Municipality territory from excess vehicles and promoting clean healthy transportation (walking, cycling). The total number of transport riding in the Municipality in 2012-2014 including tourist transport has grown by 15%.

Table 4. The Trend of Motor Transport Increase on the Territory of Mtskheta[8]

Year	Total	Motor Vehicles	Town Minibuses	Vehicles Serving the Municipality	Trucks	Intercity	Tourist Vehicles and others
2012	3 962	1 420	8	10	18	6	2 500
2013	4 222	1 470	8	20	18	6	2 700
2014	4 552	1 500	8	20	18	6	3 000
Growth (%)	15	6	0	100	0	0	20

[8] Reliability of the statistics given in this Table is very low, as Mtskheta became a self-governing entity in 2014 and there is no independent statistics for the town. Consequently, the numbers are given based on assessments.

As Table 4 shows, the rate of motor transport growth is not too high in Mtskheta Municipality but the growth of tourists' flow is significant, and, accordingly, the growth of the transport which serves tourism is the same. Namely, if in 2012, 2500 tourist vehicles (cars and buses) used to enter into Mtskheta daily, in 2014 the total number of this transport made up 3 000 units, or, it was increased by 20%.

The increase of emissions, environment pollution and annoying noise is the final result of the increased number of damaged motor roads and vehicles on the territory of the city, which is inserted in the list of UNESCO World Heritage.

Information on the fuel consumption by the vehicles registered in 2014 at the territory of Mtskheta according to their types is given in Table 5. The data of transport and the fuel consumed by it was collected on the basis of questioning Municipality departments and LLC, bus stations, population, state subordinate bodies, and gas filling stations.

Table 5. Number of Permanently Owned Vehicles and Tourist Transportation Means Driving through the Territory of Mtskheta according to the Types of Fuel in 2014

Vehicles	Passenger cars (except for taxi and municipal vehicles)	Vehicles serving municipality	Motorcycles	Minibuses (Tbilisi-Mtskheta)	Minibuses (passenger, Inner City)	Taxi	Light-duty Trucks (2 tons carrying capacity)	Heavy-duty Trucks	Tourist Vehicles
Gasoline-powered	937	20	2	0	0	0	0	0	1874
Diesel-powered	333		0	6	8	9	2	12	665
Natural gas-powered	230		0	0	0	18	0	4	461
Total	1 500	20	2	6	8	27	2	16	3000

Source: Mtskheta City Hall

Fuel consumption in city of Mtskheta is distributed in the following way: natural gas – 22%, gasoline – 57%, and the rest 21% is diesel consumption.

Table 6. Growth of Fuel Consumption

Fuel Type	2012	2014	Growth (%)
Gasoline (L)	1 611 259	2 225 855	38
Diesel (L)	549 977	726 284	32
Natural gas (m^3)	643 251	830 293	29

In line with vehicle number increase, it's natural, fuel consumption has also grown: consumption of gasoline is increased by 38%, diesel – by 32%, and gas – by 29%.

Municipal Transport

One of the problems in Mtskheta Municipality Transport Sector is the fact that the city does not have any municipal transport that obviously causes increase of riding by private vehicles.

Number of minibuses riding through the territory of Mtskheta in 2014 is given in Table 7.

Table 7. Public Transport (Minibuses) Riding in Mtskheta in 2014

Minibuses	Only on the Territory of Mtskheta	Tbilisi – Mtskheta (8km on the territory of Mtskheta)
Diesel-powered	8	6
Natural gas-powered	0	0

Source: Mtskheta City Hall

Data on fuel consumption by different types of transport and average run which was used for assessment of fuel consumption is given in Table 8. For calculation of the fuel consumption the transport which rides on inner routes of the Municipality was used.

Table 8. Features of the Transport Riding on the Terrirory of Mtskheta[9]

Vehicles	Passenger cars (except for taxi and municipal vehicles)	Vehicles serving municipality	Motorcycles	Local Minibuses (passenger)	Taxi	Light-duty (2 tons carrying capacity)	Heavy-duty Trucks	Tourist Vehicles
Annual run (km/vehicle)	24 820	12 775	6 570	29 200	18 600	10 000	18 250	2 920
Average fuel consumption per 1 vehicle on Gasoline (l/100km)	7.2	10.0	4.8					9.6
Average fuel consumption per 1 vehicle on Diesel (l/100km)	5.61			10.0	5.7	10.0	27.0	7.81
Average fuel consumption per 1 vehicle on Natural gas (m^3/100km)	10.87				9.8		30.0	11.44

Source: Mtskheta Municipality

[9] This table does not include the intercity and tourist transport which rides on the territory of the city. They are discussed separately.

3.2 Base Year (2014) Inventory and GHG Emissions Baseline Scenario (2015-2020) for Transport Sector

Methodology of the GHG emissions calculation for base year and baseline scenario is given in Appendix I.

The Mtskheta Transport Sector structure and base year inventory are based on 2014 data and cover the following types of transport:

- Vehicles serving the Municipality;
- Public Transport (minibuses);
- Private, commercial transport and taxis.

In 2014, fuel consumption in Transport Sector of city Mtskheta made **36 007**MWh.

Table 9. Final Energy Consumption in Mtskheta Transport Sector (MWh) in 2014

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	0	235	235
Public Transport (minibuses, taxis)	0	528	0	528
Private and Commercial Transport	6 426	5 492	15 435	27 353
Tourist Transport (buses, minibuses, motor vehicles)	1 462	1 588	4 841	7 891
Total	7 887	7 609	20 511	36 007

Therefore, in 2014, GHG emissions from Transport Sector made about **8 716** CO_2 equivalent.

Table 10. GHG Emissions from Transport Driving through Mtskheta in CO2 eq. (ton) - 2014

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	0	59	59
Public Transport (minibuses)	63	140	0	203
Private and Commercial Transport (taxis)	1 233	1 453	3 848	6 533
Tourist Transport (buses, minibuses, motor vehicles)	295	420	1 206	1921
Total	1 591	2 012	5 113	8 716

The Table 9 and Table 10 show that the share of private and commercial transport in total energy consumption and in total emissions equals to 75% and that of the transport which serve tourism equals to 22%. So, in the long-run perspective, the main target sub-sectors should be just these two groups. However, in short-run perspective developing public transport and significant limitation of entering tourist transport into the town is essential.

Forecast of emissions from Transport Sector by 2020 was done based on MARKAL GEORGIA. By 2020 the forecasting mark of the GHG emissions for Transport Sector made about **12 228** tons of CO_2 equivalent.

Increase of Transport Sector emissions according to BAU scenario is given in Fig. 7.

Fig. 7. Trend of GHG Emissions from Transport Sector according to BAU Scenario ($tCO_2eq.$)

3.3 Emissions Reduction Action Plan for Mtskheta Transport Sector

The rate of private vehicles ownership in city of Mtskheta is average. Here on every 1000 persons come 214 vehicles, which, compared to average rate, is a bit higher for Georgia.

As it was already mentioned, at the territory of the Municipality traveling by taxis and minibuses is very popular. Therefore, for the case of Transport Sector a strategic perspective is the development of comfortable and cheap, ecologically clean public transport at maximum level (it is desirable to be municipal transport, as the City Hall will be responsible for ecological cleanness), and for long-run perspective - regulation/limitation of traveling by private taxis and vehicles. To reach a target it is necessary to create and promote other alternative transportation means (walking, cycling). In the process of public transport development, providing comfort is very urgent.

After implementation of the measures considered in Mtskheta SEAP, compared to the baseline scenario, to 2020 emissions of CO_2 from Transport Sector will be reduced by 6 729 tons CO_2 equivalent that makes 77% of emissions from this sector. All the measures will be implemented by the appropriate departments of Mtskheta City Hall.

Description of Measures

Measure PT1: Substitution of Public Transport with more Comfortable and Clean Transport at the Territory of Mtskheta

At present, at the territory of Mtskheta 8 inner municipal and 6 Tbilisi-Mtskheta route minibuses are operating daily. Each minibus daily passes on the average 80km at the territory of Mtskheta. By 2020, the administration of city Mtskheta plans to substitute the existing minibuses with ecologically cleaner and more comfortable buses and instead of 14 minibuses 6 buses with 33 seats will operate in the town. For these buses two alternative versions of fuel (gas and electricity) are considered. Emissions reduction is calculated

for both types of fuel. In case of gas-powered buses, consumption of fuel by one bus will equal to 20m³/100km, and in case of electric buses – 100KWh/100km. In case of carrying out tightened parking policy on the territory of town, this municipal transport will also reduce riding private vehicles by 10% presumably.

The Municipality plans to implement this measure to 2020 but it may not be completed by this time, as the construction of a bridge across the River Mtskvari is considered to be of higher priority that requires much more expenses.

After implementation by 2020 of the measure, 678.21 t (gas) or 727.11 t (electricity) CO_2 eq. will be saved per year. Details of emissions calculation is given in the monitoring plan.

Measure PT2: Organizing Inner Transportation of Tourists by Electric Transport in City Mtskheta

Mtskheta City Hall plans to unload the city from tourist vehicles and for this purpose parking territories will be arranged at the left embankment of the River Mtkvari (Measure UP2), where external/non-local transport traveling to the city will be parked and from here electric buses will travel to the city providing transportation of people within the city in the direction of all tourist routes.

According to the present information, the daily number of "tourists" entering the city with tourist and other vehicles makes up 3000 people. To provide service to this number of tourists within the territory of the city, 8 buses (3 000 tourists /33 passengers in one bus / 12hours) it will be needed additionally, which will serve the passengers from the parking areas existing at the city entrance up to the city and within the city. The buses will ride from each end of the city once in every 7 minutes and in half an hour will cover 4-5km in the city.

Implementation of this measure is planned by 2019-2020, however for this purpose, it is needed to arrange the planned parking areas (at the left embankment of the River Mtkvari) and toughen the parking policy in the city. Consequently, this measure is expected to be implemented after 2020.

As a result of this measure, or using electric buses, by 2020, 1 891 t CO_2 eq. emission will be saved annually. The details of emissions calculation is given in the monitoring plan.

Measure UP1: Rehabilitation of Road Pavement

In total, in Mtskheta Municipality there are 50 streets and 8 blind lanes. The total length of the streets makes up 100km. The length of the central street (Narekvavi-Mtskheta-Railway Station) is 8km. Of the total road pavement, 70km is asphalted but 57% of this road is damaged, 5% is graveled, and the rest 25% is not asphalted at all and needs to be asphalted. About 95% of total amount of the city transport rides through these damaged roads and only 5% rides through the well-arranged roads.

In recent years, rather a considerable progress is noticed in terms of road infrastructure development and road pavement. In 2012-2014 in total 15km of motor road was paved and arranged in the city. In 2015, 5km, and in 2016 – 10km of road was laid in the whole Municipality.

70% of the road cover needs a complete rehabilitation. 30% of the road to be rehabilitated needs asphalt pavement and 40% of already asphalted road needs changing the completely damaged pavement. Thus, as the relevant studies show, in case of complete rehabilitation of the road cover, the emissions from Transport Sector riding through 70% of the road to be rehabilitated on the territory of city Mtskheta may be reduced at least by 6% to 2020.

As a result of this measure, 348 t CO_2 eq. emissions will be saved annually. Other details of the measure see in the monitoring plan.

Measure UP2: Construction of Two Additional Bridges across the River Mtkvari

This measure implies optimization of transport routes in order to reduce the travel distances. In particular, construction of two new bridges is planned across the River Mtkvari (conditionally, "Bridge 1" and "Bridge

2"). "Bridge 1" will unload the city from riding vehicles of Mtskheta local population by minimum 50%, and tourists – by minimum 30%. Near the bridge, on the left embankment of the River will be arranged a parking square will be arranged.

"Bridge 2" - will be a 100m length overpass for pedestrians across the River Mtkvari reaching Svetitskhoveli Cathedral by short distance and will serve mostly the pilgrims and tourists. Near this bridge, on the left embankment of the River Mtkvari a parking square will also be arranged. Presumably, this bridge will unload additionally 30% of tourists and pilgrims, especially, during religious holidays.

As a result of this measure ("Bridge 1"), only with reducing the travel distance of local population by 50%, every year will be saved 3 267 t CO_2 eq. emission by 2020. Other details of the measure see in the monitoring plan.

Measure PRT1: Toughening Parking Policy at the Territory of City Mtskheta

Existing parking policy of Mtskheta Municipality is mainly focused on tourist vehicles. Once a year, when the religious holiday "Svetistkhovloba" is celebrated and a big number of pilgrims arrive in Mtskheta, the entrances into the city are closed for transport and people can only be moved on foot or by municipal transport. Aimed at the reduction of the GHG emissions from Transport Sector and better development of tourism, the city administration plans to toughen the parking policy and arrange chargeable areas for parking of private vehicles and taxis. Generally, arranging parking squares both in town and in the adjacent areas is one of the first priorities of this strategy.

Arranging new areas for parking in the territories adjacent to the city is discussed in measure UP2.

On the territory of Mtskheta, about 4 581 different types of vehicles ride daily, consuming in total 36 007 MWh/yr energy and generating 8 716 t CO_2 eq. GHG emission. By 2020 when it is planned to implement this measure it is expected to release 12 228 t CO_2 eq. emission from Transport Sector.

Based on the existing sources of evaluation of measures for reduction of emissions from Transport Sector, it is revealed that in those places where parking system is well-arranged, the riding distance per vehicle is reduced by 7-10%. An assumption was made for city Mtskheta that reduction will be enacted by 7% at the expense of only private and commercial vehicles.

Based on this assumption, in case of implementing this measure, emission from private motor vehicles to 2020 will be reduced by 457 (6 533*0.07) t CO_2 eq.

Measure PRT1. Promotion of walking and cycling

In small towns travel by bicycle and walking is one of the most effective and, what's more, very healthy alternative to travel by road transport. However, it faces some important barriers one of which is attachment of population to vehicles and apprehending it as the social status defining criteria. Therefore, it is crucial to overcome this stereotype within the population and make walking and cycling more popular. For popularization of this kind of transportation some campaigns should be launched which will introduce them to people as modern, European and effective approaches both from the point of transportation and maintaining healthy environment. In this process, it is very important to develop comfortable infrastructure for pedestrians and cyclists, especially in tourist areas.

To encourage walking among the people, the Mtskheta City Hall will continue implementing measures of arranging pavements and crossings in order walking to become comfortable and safe. Improving the conditions for travel of disabled people will also be considered. For the moment, the Municipality does not have any concrete plan but it schedules to develop the plan in the nearest future.

It is planned to arrange a 7km length bicycle path on the territory of Mtskheta.

For this measure, emissions reduction has not been calculated but the City Hall acknowledges that such measures are very important for the whole process and sustainable development of the town. Namely, comfortable bicycle and pedestrian roads are essential during toughened parking policy and for limiting tourist transport riding into the city and increasing ecologically clean transport.

Table 11. Action Plan for the Mtskheta Transport Sector

Sectors and Spheres of Activity	Key Measures in Separate Sector	Responsible Department, Person or Company (in Case of Engaging the Third Party)	Start and End Dates	Expected Energy Savings from an Activity (MW/h)	Expected Reduction of CO_2 Emissions from an Activity (T)	Cost GEL
Public Transport	Measure PT1. Substitution of Public Transport on the territory of Mtskheta with more comfortable and clean transport	Spatial Planning, Architecture, Construction and Infrastructure Service of Mtskhetal City Hall	2018-2019	2 874	727	3 500 000 (1 gas-powered bus 350 000 GEL and 1 electric bus cost 600 000 GEL)
Public Transport	Measure PT2. Organizing inner transportation of tourists with electric transport	Spatial Planning, Architecture, Construction and Infrastructure Service of Mtskhetal City Hall	2019-2020	7 658	1891	7 000 000 (1 electric bus cost 600 000 GEL)
Improvement of Road Infrastructure	Measure UP1. Rehabilitation of road cover	Spatial Planning, Architecture, Construction and Infrastructure Service of Mtskhetal City Hall	2015-2020	1437	348	
Improvement of Road Infrastructure	Measure UP2. Construction of two new additional bridges across the River Mtkvari	Spatial Planning, Architecture, Construction and Infrastructure Service of Mtskhetal City Hall	2019-2020	13 521	3 267	
Limiting Private Vehicles	Measure PRT1: Setting up of Parking System in Mtskheta	City Hall and City Council of Mtskheta	2017-2020	1893	457	
Promoting Clean Transport	Measure PRT2. Promotion of Pedestrians and Cyclists	Spatial Planning, Architecture, Construction and Infrastructure Service of Mtskhetal City Hall	2017-2020			
Total				**20 254**	**6 730**	

4 Buildings

4.1 Overview of the Sector

One of the key points of the SEAP is the Buildings Sector in the City of Mtskheta, which alongside with the residential buildings includes municipal and other commercial buildings as well (offices, shops, hotels, etc.). In the process of reduction of the GHG emissions from the territory of the city, the role of this sector is rather significant, and, hence, the energy-efficiency measures for these buildings and the increasing consumption of renewable energies should be planned with special attention.

Total Fund of Mtskheta Buildings

At the territory of Mtskheta City, like in other cities, different types of buildings are disposed: municipal, governmental, and residential (individual and multi-apartment) ones. Among the residential buildings, two-story, three-story, four-story and five-story buildings are presented. Private residential houses are one and two-story buildings.

Information on the residential buildings in the City of Mtskheta is given in Table 12.

Table 12. Residential Buildings in Mtskheta

Building	Number of Stories	Number of Entrances	Quantity	Total Areas (m^2)
Multi-apartment buildings	2	1	16	5 805
	2	2	13	6 555
Total			**29**	**12 360**
	3	1	3	894
Total			**3**	**894**
	4	1	2	1 022
	4	4	1	705
Total			**3**	**1 727**
	5	1	8	3 353
	5	2	12	5 388
	5	3	2	1 040
	5	4	2	1 608.8
Total			**24**	**11 389.8**
Total multi-			**59**	**26 370.8**

apartment buildings:				
Total Private Residential Buildings:	1, 2		**1 012**	**78 936**
Total			**1 071**	**105 307**

The presented information about total areas of residential buildings was obtained from the Administration of Mtskheta, provided by the experts and the auditors based on the data of the survey and registration of the buildings.

Individual residential houses and two, three, four and five-story multi-apartment buildings represent the modern architecture of Mtskheta.

For construction materials of the walls of private houses stone, brick and blocks and for roofing - tin sheeting and tiles were used.

The multi-apartment residential buildings were built in the 60-80es of the last century. For construction materials concrete blocks (panels), for roofing – tin and tiles were used. In residential multi-apartment buildings the roofs have been replaced but they need thermal insulation; thermal insulation is needed in entrances of the multi-apartment buildings (the entrances have no doors and windows), but as for windows, about 60% of the apartment windows are replaced with metal-plastic ones. As for the private individual residential buildings, in these buildings the roofs need to be insulated; about 55% of windows of these houses are also replaced with metal-plastic frames.

Besides the residential buildings, state and municipal buildings are located in the city. There are also different types of commercial buildings (restaurant, cafes and bars, hotels, shops, salons, gas filling stations, banks, bus terminal, bakeries, drug stores, etc.).

In the possession of city Mtskheta Municipality there are 23 buildings with total area of 13 173m^2, 5 of which are kindergartens. The numbers and areas of buildings and kindergartens belonging to the city are given in Table 13.

Table 13. List of Buildings and Premises Belonging to Mtskheta (except of kindergartens)

#	Buildings	Number	Total Area (m^2)
1	Municipal Buildings	18	10 819
2	Kindergartens and Nurseries	5	2 354
	Total	**23**	**13 173**

Besides municipal buildings, there are state-owned ones (for example, schools, medical institutions and commercial buildings). The list of these buildings is given in Table 14.

Table 14. Incomplete List of State-owned and Commercial Buildings Functioning in Mtskheta

№	Name of Realty	Number	Area, m^2
1	Public Schools	4	36 059
2	Commercial Buildings	53	15 884
	Total	57	51 943

Energy Consumption by Buildings Sector in City Mtskheta

Information on energy consumption by the Buildings Sector in the City of Mtskheta was obtained from different sources[10]. Namely, information about energy consumption was obtained from "EnergoProGeorgia" distributing electric energy in the City of Mtskheta. Information about consumption of natural gas was obtained from Gas Company "Socar" supplying the city with gas. Information on consumed firewood quantity in the buildings was collected from Mtskheta Municipality. The summed up information on consumption of different types of fuel in buildings is given in Table 15.

Table 15. The Trends of Energy Resources (MWh) Consumed by the Buildings in Residential and Non-residential Sectors of Mtskheta in 2012-2014

Type of the Buildings	Total area (m^2)	Consumption KWh/yr/m^2	Consumption W/m^2	2012	2013	2014	Increase (%)
Residential Buildings	**105 307**	**276**	**32**	**19 743**	**23 218**	**29 094**	**47**
Municipal Buildings and kindergartens	**13 173**	**173**	**20**	**1 858**	**2 126**	**2 280**	**23**
Commercial Buildings and Schools	**51 943**	**68**	**8**	**2 616**	**3 200**	**3 515**	**34**
Total Energy Consumption	**170 423**			**24 217**	**28 544**	**34 889**	**44 (average)**

In Table 15 only consumption of electric energy and natural gas is presented as, according to the information of Mtskheta City Hall, consumption of firewood is very small (100m^3 per year) and mostly it is consumed by private individual buildings. Table 15 shows that in 2012-2014 the energy consumption in Buildings Sector has increased by 44%, of which the highest growth – 47% is in residential sector. The highest consumption per 1m^2 area (32 W/m^2) is also revealed in residential buildings[11] and the most efficient consumption (8 W/m^2) - in commercial buildings (which includes schools and other state-owned buildings).

[10] City of Mtskheta became a self-governing city in 2014 and it was separated from the Mtskheta Municipality but this separation is not completed yet in "EnergoProGeorgia" and "Socar" systems. Consequently, the city's consumption was separated from total consumption based on the experts' assessments that is related to a rather big inaccuracy.

[11] Of course, these numbers do not show the real demand on heating season but they show an average annual consumption.

Here we should also consider the fact that in Georgia the buildings are not heated completely, the temperature of heating is not always sufficient and, of course, the non-reliability of the statistics is obvious.

Table 16 shows the energy consumption according to fuel type and building category in natural units of fuel, the total amount of which equals to 165 490MWh.

Table 16. Energy Resource Consumed by the Buildings in Residential and Non-residential Sectors of Mtskheta in 2014

Sub-sector of the Buildings	Electric Power (KWh)	Natural Gas (m^3)	Firewood (m^3)
Residential	2 845 335	2 701	100
Municipal	377 025	196	0
Other Buildings (Schools and Commercial Buildings)	378 821	323	0
Total	3 601 181 (3 601MWh)	3 219 (31 295MWh)	100 (285MWh)

4.2 Methodology

For carrying out of baseline (2014) CO_2 emission inventory from the Buildings Sector and defining future trends (by 2020) the methodology was used given in Appendix I. This methodology also includes carbon dioxide emission factors and transfer coefficients, but as for methane and nitrous oxide emission factors resulted from incomplete combustion of fuel, they were taken from the IPCC 1996 and are shown in Table 17.

Table 17. Methane and Nitrous Oxide Emission Factors for Buildings (kg/MWh)

GHG	Natural Gas	Oil Products	Firewood
CH_4	0.01800	0.036	1.080
N_2O	0.00036	0.002	0.014

As for the emissions reduction potential resulted from energy-saving measures, it has been assessed by selecting typical buildings for the city of Mtskheta, carrying out energy audits and evaluating energy efficiency measures, then transposing these results to other buildings. Energy audit methodology is given in Appendix II.

In short, it could be said that assessment of the energy consumption from Buildings Sector and calculation of carbon dioxide emissions may be conducted according to three different scenarios (E_1=E_2=E_3): first scenario (E_1) –the annual energy consumption from Buildings Sector (electricity, gas, firewood suppliers) obtained

from different sources; second scenario (E_2) - based on energy consumption and calculated for unit area after auditing different types of buildings which will be generalized on the entire existing area; and third scenario (E_3) - also based on the buildings auditing or surveys, calculated with multiplying energy consumption per capita by the number of population. Comparing the results of these three scenarios makes it possible to identify the accuracy of calculation according to each scenario ($E_1=E_2=E_3$).

To develop the SEAP for City of Mtskheta, detailed energy audit was conducted in July 2016 and 9 different facilities were selected for this purpose, which were different from one another with energy resource consumption features. They are:

Nursery-Kindergarten #4 of City Mtskheta (David Aghmashenebeli Street #150)

Public School #1 of City Mtskheta (David Aghmashenebeli Street #71)

Two-story Residential Building (Antiochia Street #2)

Three-story Residential Building (Antiochia Street #6)

Five-story multi-apartment building (David Aghmashenebeli Street #97)

IDPs' Multi-apartment Residential Building (Tsereteli Street #4)

Private Residential House (Gamsakhurdia Street #24)

Municipal Building (Mamulashvili Street #14)

Private Hotel (Kostava Street #35)

Picture 1. Buildings of City Mtskheta

After defining specific energy costs, annual energy consumption (E_2, KWh/yr) in buildings for heating, hot water, cooking and electric appliances was identified for different types of buildings.

The third scenario of methodology (E_3) is based on statistical data about the number of residents in the populated facility. Identifying the energy cost calculated per capita (KWh/yr per capita) makes it possible to calculate the annual energy consumption for the entire population (E_3, KWh/yr).

4.3 Base Year (2014) Inventory and GHG Emissions Baseline Scenario (2015-2020) for Buildings Sector

As it was already mentioned above, according to Guidelines of developing SEAP, three sub-sectors are considered in the structure of the city's Buildings Sector, which include: municipal buildings, residential buildings and others (commercial buildings).

City of Mtskheta is completely electrified and power supply is provided to all the populated areas. However, the main problem is incomplete installation of meters among population (only 58.7%) that creates difficulties in administration of electricity bills and it represents a big problem in energy efficiency implementation process.

Energy consumption in Buildings Sector is given in Table 18.

Table 18. Final Energy Consumption in Mtskheta Buildings Sector (MWh) – 2014

#	Subsector	Electric Energy	Natural Gas	Firewood	Total
1	Municipal Buildings	377	1 903	0	2 280
2	Other (Commercial) Buildings	379	3 137	0	3 516
3	Residential Buildings	2 845	26 255	285	29 386
	Total	3 601	31 295	285	35 182

Consequently, in 2014 GHG emission from buildings made up about 24.2 thousand tons CO_2eq. The 2014 power grid average emission factor is considered as the power emission factor – 0.104 tons CO_2eq/MWh.

Table 19. GHG Emission from Mtskheta Buildings Sector in 2014 (t CO2 eq.)

#	Subsector	Electric Energy	Natural Gas	Firewood	Total
1	Municipal Buildings	39.21	383.47	0.00	422.68
2	Other (Commercial) Buildings	39.4	631.98	0.00	671.37
3	Residential Buildings	295.91	5 289.63	120.3	5 705.85
	Total	374.52	6 305.08	120.3	6 799.90

The baseline scenario of emissions calculated by the MARKAL Georgia coefficients for 2020 will be increased by 36.5%.

According to information of 2013, 100% of population is supplied with natural gas in Mtskheta City. Only 2-3% is not provided with gas supply system.

The future increase by 36% will imply only electricity and natural gas from which the total emission in 2014 was 6.8 thousand t CO_2 eq. Thus, the increase by 36% from consumption of electricity and natural gas will equal to 9.08 thousand t CO_2 eq. Consequently, total emission (including firewood) expected by 2020 will equal to 9.2 thousand t CO_2 eq., that in total makes the emission increase by 36%.

The Figures (Fig. 8, Fig. 9, Fig. 10) show CO_2 eq. emission from City Mtskheta Buildings Sector both total, and according to types of buildings and fuel in 2016-2020.

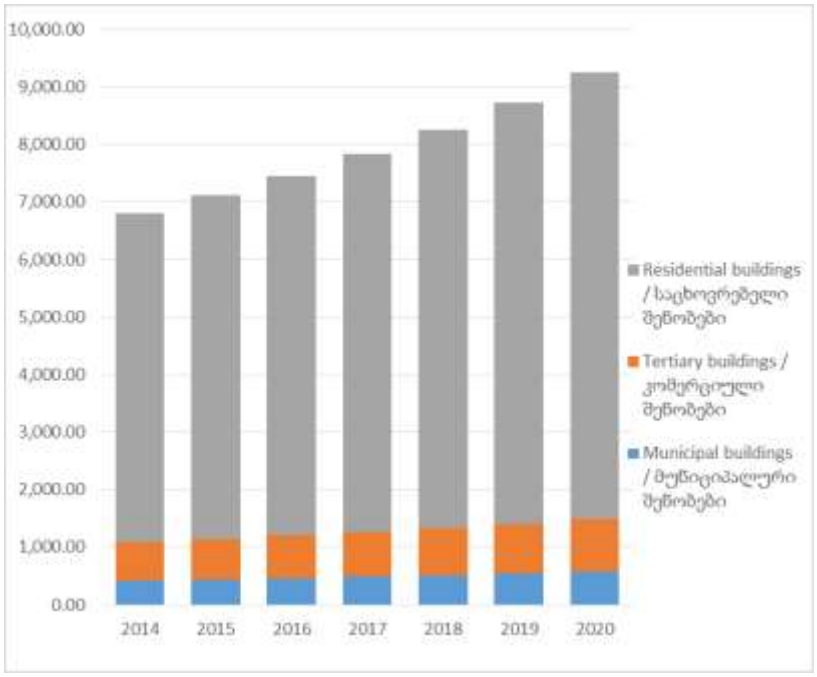

Fig. 8. Business As Usual (BAU) Scenario until 2020 according to the Types of Buildings

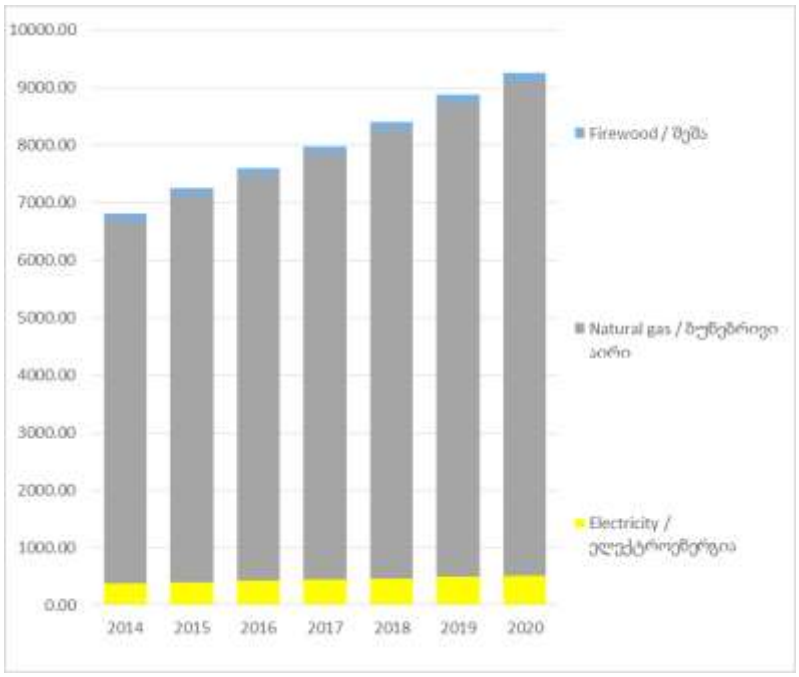

Fig. 9. Business As Usual (BAU) Scenario until 2020 according to the Types of Fuel for Buildings Sector

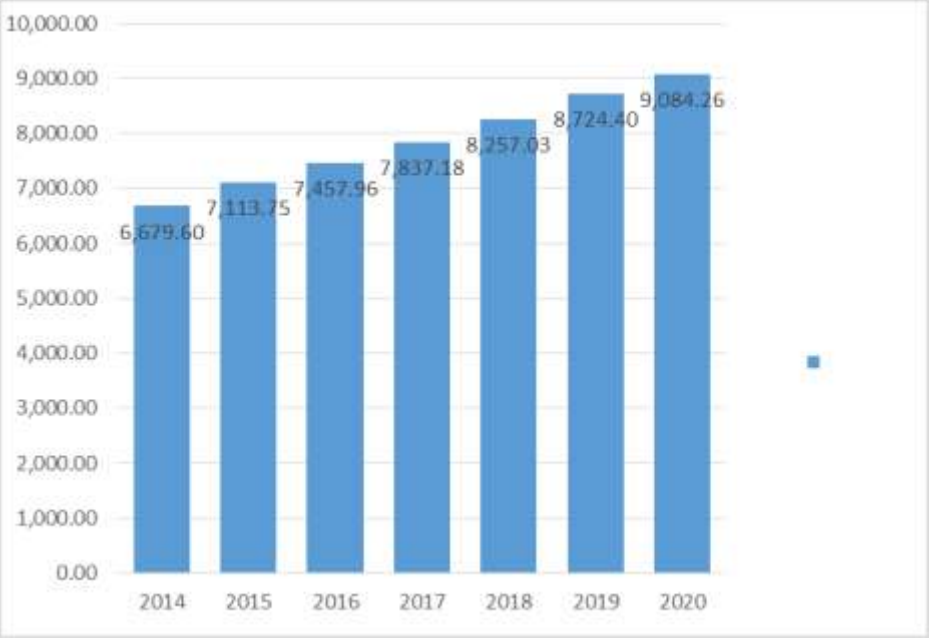

Fig. 10. Business as Usual (BAU) Scenario until 2020 for Buildings Sector

4.4 Emissions Reduction Action Plan for Mtskheta Buildings Sector

As it could be seen from Table 19, 84% of GHG emissions from Buildings of City Mtskheta are released from residential buildings[12]. Therefore, to achieve the 20% mark in emissions reduction by 2020, it is of utmost importance to develop sector programs facilitating the introduction of energy efficiency and renewable energy adoption measures in the residential buildings. At the same time, it should be considered that the energy consumption in the City of Mtskheta is low as the buildings are not completely heated and large part of population lives in energy poverty. So, such programs require carrying out of serious preparatory activities, working with donors in search of external financing, specification of legislative basis and regulations to enable the city administration to work directly with the population to carry out the corresponding projects. Mtskheta City Hall takes into consideration that in time of the preparation of this plan only 5 years remain till 2020 and hence it is possible that implementation of such programs with their full capacity may not be managed by 2020. Therefore, more realistic will be reaching (-40%) mark of emissions reduction by 2030 as it is considered in the new Covenant of Mayors, and joining to which will be discussed by Mtskheta in the closed future. In the nearest 5 years, the strategy of Mtskheta City Hall envisages maximal substantiation of energy saving and use of renewable energies in municipal buildings to demonstrate the advantages of this approach to the population and other commercial buildings. Besides, the energy-saving measures will be popularized and promoted for the residential buildings, which the City Hall has already planned co-financing programs for. These are the dwellers cooperatives (multi-apartment buildings).

The short-run strategy of GHG emission reduction from municipal and residential buildings at the territory of Mtskheta implies reduction of consumption of energy resources through implementing such measures as: improving thermal insulation of attics and common areas of entrances in residential buildings; sealing

[12] It should be considered that it was impossible to obtain information on energy consumption by commercial buildings that would have changed the picture significantly.

fissures, cracks and gaps of windows and doors to reduce infiltration that saves rather a big amount of heating energy and at the same time it is comparatively simple measure.

An available and efficient measure is also installation of sensor lighting system in the entrances of multi-apartment buildings. It's natural that the mentioned measures should be preceded by information campaigns and corresponding trainings to raise awareness of the population.

A very perspective way of reduction of carbon dioxide is application of renewable energy sources. As it is known, in the buildings the main part of energy resources is used for heating and hot water supply. Hence, application of bio waste and solar energy as the sources of renewable energy for heating and hot water supply systems in buildings will significantly reduce the natural gas amount and consequently – carbon dioxide emission.

The Emissions Reduction Action Plan for the existing buildings is presented in Table 35, and below is given the descriptions of measures.

Measure MB 1.1 Thermal Insulation of Attics in Municipal Buildings

The measure is considered to be implemented in Municipal Building of City Mtskheta (Mamulashvili Street #12).

As a result of implementation, the expected energy-saving was calculated by the ENSI computer program and makes 10 447 KWh/y that is equivalent of 10 447/ (9.7x0.9) = 1 197m^3/yr natural gas. Considering the tariff of natural gas ((0,829GEL/m^3) the annual saving will equal to 1 197 x 0.829= 992 GEL. Accordingly, CO_2 emission reduction will equal to 10 447 x 0.202/1000 = 2.1t/yr.

The ceiling area of this municipal building is 225m^2. The expected energy saving per m^2 makes up 10 447/225=46.4KWh/yr/m^2. The equivalent natural gas expenditure will be 1 197/225=5.3m^3/yr/m^2 and emission will equal to 2.1/225=0.0094t/yr/ m^2.

To implement the thermal insulation of the attic the required investment makes up 225 x 20 = 4 500GEL.

Considering the total area of the ceilings of all municipal buildings in the City of Mtskheta (total area 4 050m^2), energy-saving, gas expenditure and emission will be: 46.4 x 4 050 =188 046KWh/y; 5.3 x 4 050 =21 540m^3/y; 21 540 x 0.827 = 17 867GEL/y; 0.0094 x 4 050 =38t/y; Investment required for thermal insulation of the attics is 4 050 x 20 = 81 000GEL.

Profitability parameters of measure MB1.1 are given in Table 20.

Table 20. Profitability Parameters of Measure MB1.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Thermal insulation of attic at the selected facility	4 500	4.5	21.7	1.13	2.1
Thermal insulation of attic at all municipal buildings	81 000	4.5	21.7	1.13	38

*PB – Payback Period; *IRR – Internal rate of Return; *NPVQ - Net Present Value Quotient

Measure MB 1.2. Thermal Insulation of Attics in Kindergartens

The measure is considered to be implemented at the building of Mtskheta Kindergarten #4. The expected energy saving resulting from the implementation of this measure makes 32 402 KWh, that is equivalent to 32 402/ (9.7x0.9) = 3 712m^3/y natural gas. Considering the tariff of natural gas ((0,829GEL/m^3) the annual savings will equal to 3 712 x 0.829= 3 077GEL. Accordingly, CO_2 emission reduction from buildings will equal to 32 402 x 0.202/1000 = 6.5 t/yr.

The ceiling area of building of Mtskheta Kindergarten #4 is 453m^2. The expected energy-saving per sq.m makes up 32 402/453=71.5KWh/yr/m^2. The equivalent natural gas expenditure will be 3 712/453=8.2m^3/y/m^2 and emission will equal to 6.5/453=0.0144t/yr/m^2. The needed investment for implementation of thermal insulation of the attic makes up 453 x 20 = 9 060GEL.

Considering the total area of the ceilings of all kindergartens of the City Mtskheta (total area 2265m^2), energy saving, gas expenditure and emission will be accordingly: 71.5 x 2 265 =162 010 KWh/yr; 8.2 x 2 265 =18 558m^3/yr; 0.0144 x 2 265 =32.7t/yr.

Investment required for thermal insulation of the attic is 2 265 x 20 =45 300 GEL.

Table 21. Profitability Parameters of Measure MB1.2

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Thermal Insulation of the Building Attic in ne kindergarten	9 060	3.0	33.2	2.22	6.5
This measure is considered for kindergartens (5)	45 300	3.0	33.3	2.22	32.7

Measure MB 2.1. Installation of New Lighting System in Municipal Building

The energy-saving resulted from the implementation of this measure has been calculated by ENSI computer program and makes up 1 618 KWh/y considering the electricity tariff (0.199GEL/KWh) the annual savings in monetary terms make up 1 618 x 0.199 = 322 GEL. Accordingly, reduction of CO_2 emission from the buildings will equal to 1 618 x 0.104 /1000 = 0.168t/y.

In this building, it is needed to substitute 27 units of 100W incandescent bulbs with 40W LED bulbs the cost of which is 15GEL/1 bulb. To complete the measure the needed investment equals to 27 x 15=405GEL.

In municipal buildings of Mtskheta, the saving of demanded power for lighting per 1 m^2 makes 2.5 W/m^2. Considering the areas of municipal buildings (total area 10 819m^2) the power-saving will be 10 819 x 2.5/1000 =27KW. Duration of the bulb operation is 50hour/week, and per year number of weeks is 52weeks/yr. Consequently, the energy-saving will equal to 27 x 50 x 52 =70 824 KWh/yr.

100W bulbs in the buildings should be substituted with 40W LED bulbs, that equals to 27 000W/40W = 675units, the cost of which is 15GEL/1unit. The investment needed for implementation of the measure will be 675 x 15=10 125GEL.

Accordingly, CO_2 emissions reduction from buildings will be 70 824 x 0.104 /1000 = 7.3 t/yr.

The profitability parameters of measure MB 2.1 are given in Table 22.

Table 22. Profitability Parameters of Measure MB2.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
New lighting system for the selected facility	405	1.2	81.5	6.87	0.17
New lighting system for all municipal buildings	10 125	1.2	81.5	6.87	7.3

*PB – Payback Period; *IRR – Internal rate of Return; *NPVQ - Net Present Value Quotient

Measure MB 2.2. – Installation of New Lighting System in the Building of Kindergarten

The energy-saving resulted from the implementation of this measure has been calculated by ENSI computer program and makes up 861 KWh/y, considering the electricity tariff (0.199GEL/KWh) the annual savings in monetary terms make 861x 0.199 = 171GEL. Accordingly, reduction of CO_2 emission from the buildings will equal to 861 x 0.104 /1000 = 0.089t/yr.

In the building, it is needed to substitute 45 units of 100W incandescent bulbs with 40W LED ones, which costs 15GEL/1 bulb. For completing this measure the needed investment equals to 45 x 15=675 GEL.

In Mtskheta kindergartens, the saving of the demanded power for lighting per 1 m^2 makes 2.5W/m^2. Considering the area of kindergarten buildings (total area 4 354m^2) the power saving will be 4 354 x 2.5/1000 =10.8KW. The duration of the bulbs operation is 20hour/week, and per year number of weeks is 52 weeks/yr. Consequently, the energy-saving will equal to 10.8 x 20 x 52 =11 232 KWh/yr.

In the buildings 100W ordinary bulbs should be substituted by 40W LED bulbs, that equals to 10800W/40W = 270units the cost of which is 15GEL/1unit. The investment needed for implementation of the measure will be 270 x 15=4 050GEL.

Accordingly, CO_2 emissions reduction from buildings will be 11 232 x 0.104 /1000 = 1.17 t/yr.

The profitability parameters of measure MB 2.2 are given in Table 23.

Table 23. Profitability Parameters of Measure MB 2.2

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y

New lighting system for the selected facility	675	4.0	21.6	0.67	0.089
This measure is considered for kindergartens (5)	4 050	4.0	21.6	0.67	1.17

Measure MB 3.1. Application of Solar Collectors in Kindergartens

The solar energy collectors convert solar radiation into heat transferred then to water, which may be supplied to the building. The above-discussed measure aims to use solar collectors to supply hot water to such municipal buildings as kindergartens. About 4000 liters of hot water is used daily in kindergartens for which 24 907 KWh of energy is needed annually.

In Mtskheta Municipality the solar collector will generate 1 050 KWh/m^2 per year. In case of using vacuum solar collectors, mounted at the roofs, a total area 24m^2 may get annually 25200KWh heating energy per year.

The surface area of a standard solar collector is 2m^2 and costs 1 300GEL. In our case, we will need 12 such collectors and accordingly the investment costs will be 15 600GEL.

Considering this, to get the mentioned energy (25 200KWh/yr) from combustion of natural gas it would require the gas in the amount: 25 200 / (9.7 x 0.9) = 2 887 m^3, the money equivalent of which is 2 978 x 0.829 = 2 393GEL. If natural gas is changed to solar energy the reduction of CO_2 emissions will be 25 200 x 0.202/1000 = 5.1t/yr.

The profitability parameters of MB 3.1 measure are given in Table 24.

Table 24. Profitability Parameters of Measure MB 3.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Application of Solar Collectors per one kindergarten	15 600	7.1	12.8	0.36	5.1
This measure is considered for kindergartens (5)	78 000	7.1	12.8	0.36	25.5

Measure RB 1.1. - Thermal Insulation of Multi-apartment buildings Attics

Heat-saving assessments as a result of thermal insulation of attics in multi-apartment buildings are taken based on the conducted auditing and are given in Table 25.

Table 25. Energy-saving with Insulation of Attics in Multi-apartment buildings

#	Number of stories	Number of Multi-apartment buildings	Attic Area in one Multi-apartment building m^2	Attic Area in all Multi-apartment buildings m^2	Energy-saving at Unit Area of Attic KWh/y/m^2	Annual Energy-saving in one Multi-apartment building KWh/y	Annual Energy-saving in all Multi-apartment buildings KWh/y
1	2- story multi-apartment buildings	16	324	5184	75.1	24 347	389 552
2	2- story multi-apartment buildings	13	648	8424	75.1	48 665	632 645
3	3- story multi-apartment buildings	3	310	930	67.7	20 962	62 886
4	4- story multi-apartment buildings	2	168	336	74.5	12 516	25 032
5	4- story multi-apartment buildings	1	336	336	74.5	25 032	25 032
6	5- story multi-apartment buildings	8	168	1 344	74.5	12 516	100 128
7	5- story multi-apartment buildings	12	336	4 032	74.5	25 038	300 456
	5- story multi-apartment buildings	2	504	1 008	74.5	37 548	75 096
	5- story multi-apartment	2	672	1 344	74.5	50 064	100 128

	buildings						
8	4- story multi-apartment building of IDPs	3	450	1 350	63.8	28 698	86 094
	Total			24 288			1 797 049

The total amount of savings makes up 1 797 049 KWh/y, that will result in reduction of CO_2 emission 1 797 049 x 0.202/1000 = 363 t/yr.

Accordingly, the saving of natural gas makes up about 1 797 049/ (9.7x0.9) = 205 847m^3. The money equivalent of this saving will be 205 847 x 0.53 = 109 099GEL per year.

The investment will be 24 288m^2 x 20 GEL/m^2 = 485 760 GEL.

Profitability parameters of Measure RB1.1 are given in Table 26.

Table 26. Profitability Parameters of Measure RB 1.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Thermal insulation of multi-apartment buildings	485 760	4.5	22.1	1.17	363

Measure RB 1.2. Thermal Insulation of Attics in Typical Private Houses

Heat-saving in result of thermal insulation of attics in typical private houses are taken based on the conducted auditing and makes up 8 023 KWh/yr that will result in reduction of CO_2 emission 8 023 x 0.202/1000 = 1.62 t/yr.

Accordingly, the saving of natural gas makes up about 8 023/ (9.7x0.9) = 919m^3. In monetary terms, this saving will be 919 x 0.48 = 441GEL per year.

The investment will be 78 m^2 x 20 GEL/m^2 = 1 560 GEL.

Profitability parameters of measure RB1.2 are given in Table 27.

Table 27. Profitability Parameters of Measure RB 1.2

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 Reduction ton/y

				NPVQ	
Thermal insulation of attics in typical private houses	1 560	3.6	28.0	1.73	1.62
Thermal insulation of attics in typical private houses (500)	780 000	3.6	28.0	1.73	810

Measure RB 2.1. Reduction of Infiltration from Windows of Multi-apartment Residential Buildings

Due to draught air flow the rooms are cooled very soon and an additional amount of energy is required to heat them. Through the gaps in the doors and windows the flow of cold air comes in from outside and the flow of warm air goes out. Therefore, it is necessary to provide hermeticity of doors and windows that makes it possible to reduce the energy needed for heating the room by 25-30%. To cover fissures, cracks and gaps and reducing air leaking it is possible to use very simple and cheap methods: to fill the gaps between window glass and frame with silicone, scotch or putty. It is also possible to stick scotch and special transparent plastic material from both sides of window glass and attach on the window frame surface foam rubber, penopoliurethane, silicone and rubber sealing.

Heat-savings resulted from reducing infiltration in buildings were taken based on the conducted auditing and are given in Table 28.

Table 28. Energy-saving with Reduction of Infiltration from Multi-apartment Buildings

#	Number of stories	Number of Multi-apartment buildings	Area of Windows in one Multi-apartment building m^2	Area of Windows in all Multi-apartment buildings m^2	Energy-saving with Infiltration Reduction at Unit Area KWh/y/m^2	Annual Energy-saving in one Multi-apartment building KWh/y	Annual Energy-saving in all Multi-apartment buildings KWh/y
1	2-story multi-apartment buildings	16	66	1056	169.4	11 180	178 880
2	2- story multi-apartment buildings	13	132	1716	1669.4	22036	286 468
3	3- story multi-apartment buildings	3	110	330	136.2	14 979	44 937
4	4- story multi-apartment buildings	2	104	208	102.3	10 640	21 280

5	4- story multi-apartment buildings	1	208	208	102.3	21 280	21 280
6	5- story multi-apartment buildings	8	130	1040	102.3	13 300	106 400
7	5- story multi-apartment buildings	12	263	3156	101.1	26 600	319 200
	5- story multi-apartment buildings	2	390	780	100.0	39 000	78 000
	5- story multi-apartment buildings	2	520	1040	100.0	52 000	104 000
	Total			9 534			1 160 445

The total amount of energy-savings makes up 1 160 445 KWh/y, that is equivalent to 1 160 445 / (9.7 x 0.9) = 132 926m^3 natural gas. The money equivalent of this saving will be 132 926 x 0.53 = 70 450GEL per year. The emission will be reduced by 1 160 445 x 0.202/1000 = 234.4t/yr.

With this measure, about 9 534m^2 windows will be covered. The investment for windows will make 2GEL/m^2 x 9 534m^2 = 19 068GEL.

The profitability parameters of measure RB 2.1 are given in Table 29.

Table 29. Profitability Parameters of Measure RB 2.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Reduction of Infiltration	19 068	0.3	269.8	2.42	234.4

Measure RB 2.2. Thermal Insulation of Common Places in the Entrances of Multi-apartment Buildings

The specific value of heat-savings from common places in the entrances of multi-apartment buildings makes about 2 000 KWh/yr for each staircase.

The energy-savings according to the number of the multi-apartment buildings and the entrances are given in Table 30.

Table 30. Energy Saving with Insulation of Multi-apartment buildings Entrances

#	Number of stories	Number of Multi-apartment buildings	Number of Entrances	Number of Staircases	Energy-savings KWh/y
1	2- story multi-apartment buildings	29	42	42	84 000
2	3- story multi-apartment buildings	3	3	6	12 000
3	4- story multi-apartment buildings	3	6	18	36 000
4	5- story multi-apartment buildings	24	46	184	368 000
	4- story multi-apartment buildings of IDPs	3	3	9	18 000
	Total	62	100	259	518 000

The total amount of energy-savings makes up 518 000 KWh/y, that is equivalent to 518 000/ (9.7 x 0.9) = 59 336m^3 natural gas. The money equivalent of this saving will be 59 336 x 0.53 = 31 448GEL per year. The emission will be reduced by 518 000 x 0.202/1000 = 104.6 t/yr.

The thermal insulation measure covers installation of metal-plastic windows at each floor in the openings of the entrances in multi-apartment buildings. With this measure at about 259 staircases will be needed to be installed 1.5m^2 metal-plastic windows, or in total 259 x 1.5 = 388.5m^2. The investment for windows will be 150 GEL/m^2 x 388.5m^2 = 58 275GEL.

The profitability parameters of measure RB 2.2 are given in Table 31.

Table 31. Profitability Parameters of Measure RB 2.2

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Thermal insulation of common places in the entrances of multi-apartment buildings	58 275	1.9	53.8	4.2	104.6

Measure RB 3.1 Installation of Sensor Lighting in the Entrances of Multi-apartment Buildings

The cumulative data of Mtskheta Municipality multi-apartment buildings is given in Table 32.

Table 32. Cumulative Data of Mtskheta Municipality Multi-apartment Buildings

#	Number of Stories	Number of Multi-apartment buildings	Number of Entrances	Number of Sensor Systems
1	2-story multi-apartment buildings	29	42	42
2	3- story multi-apartment buildings	3	3	6
3	4- story multi-apartment buildings	3	6	18
4	5- story multi-apartment buildings	24	46	184
5	4- story multi-apartment buildings of IDPs	3	3	9
	Total	62	100	259

The energy saving per one bulb with sensor on the average is 290 KWh/y, and emission saving is 38kg/y.

Total number of entrances of the buildings in Mtskheta Municipality is 100, and the number of bulbs – 259.

Considering the number of sensor equipments, the energy-saving from entrances of Mtskheta municipal buildings will equal to 290 x 259 = 75 110 KWh/yr and the money equivalent of which is 75 110 x 0.199 = 14 947GEL. Reduction of emission will equal to 259 x 38/1000 = 9.8 t/yr.

The cost of sensor equipment is 15 GEL, and total investment cost will be 15 x 259 = 3 885 GEL.

Profitability parameters of measure RB 3.1 are given in Table 33.

Table 33. Profitability Parameters of Measure RB 3.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Installation of sensor lighting system in the entrances	3 885	0.3	388	14.4	9.8

Measure RB 4.1. Developing High-efficient Bio-Waste Powered Thermal Generator for Private Houses

The average annual demand on heating for typical 2-story private house makes up 32 500 KWh/yr. In case of transferring from natural gas to biomass consumption, the reduction of CO_2 emission will equal to 32 500 x 0.202/1000=6.5 t per year.

The investment for implementation of this measure will be 600GEL to purchase the efficient stove. The annual saving in money equivalent will be 32 500 x 0.06 = 1 950GEL (0.09-0.03=0.06 GEL/KWh represents the difference between the costs of firewood and gas).

Presumably, the results of pilot project should imply 20 two-story residential buildings. This will increase in Mtskheta Municipality the share of renewable energy in total energy consumption.

Profitability parameters of measure RB 3.1 are given in Table 34.

Table 34. Profitability Parameters of Measure RB 4.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient NPVQ	CO2 Reduction ton/y
Per one house	600	0.3	325.0	30.0	6.5
For 20 houses	12 000	0.3	325.0	30.0	130

Table 35. Action Plan for Emission Reduction from Mtskheta Buildings Sector

Sectors and Activities	Key Measures in the sphere of Activities	Responsible Department, Person or Company [If a third party is involved]	Implementation Period [Start and End Dates]	Expected Energy Saving from each Measure [MWh/y] 2020	Expected CO2 Reduction [T/y] from each Measure 2020	Cost of each Measure [GEL]
Municipal Buildings (MB)						
Measure MB1	Improving Thermal Insulation of Attics in Municipal Buildings					
MB 1.1	Thermal insulation of attics in all municipal buildings	NELP "Infrastructure and Municipal Amenities" under Mtskheta City Hall	2017-2018	188	38	81 000
MB 1.2	Thermal Insulation of Attics in Kindergarten buildings (5)	NELP "Association of Kindergartens" under Mtskheta City Hall	2017-2018	162	32.7	45 300
Measure MB 2	Energy-efficient Lighting Systems					
MB 2.1	Installation of new lighting systems in municipal building	NELP "Infrastructure and Municipal Amenities" under	2017-2020	71	7.3	10 125

	(675 units)	Mtskheta City Hall				
MB2.2	Installation of new energy-efficient system (270 bulbs) in kindergartens (5)	NELP "Association of Kindergartens" under Mtskheta City Hall	2017-2020	11	1.17	4 050
Measure MB 3	Application of Renewable Energy Resources for Supplying Hot Water					
MB 3.1	Application of solar collectors in kindergartens (5)	LELP "Association of Kindergartens" under Mtskheta City Hall	2018-2019	125	25.5	78 000
Residential Buildings (RB)						
RB1	Thermal Insulation of Attics of Residential Buildings					
RB 1.1	Thermal insulation of attics of multi-apartment buildings	NELP "Infrastructure and Municipal Amenities" under Mtskheta City Hall jointly with Dwellers	2018-2020	1 797	363	485 760

		Cooperatives				
RB 1.2	Thermal insulation of attics in the typical private residential house (500 houses)	NELP "Infrastructure and Municipal Amenities" under Mtskheta City Hall jointly with Dwellers Cooperatives	2019-2025	4 000	810	780 000
Measure RB 2	Thermal Insulation of Multi-apartment Buildings and Other Measures					
RB 2.1	Reduction of infiltration from windows of multi-apartment buildings (9534m^2 area of windows)	NELP "Infrastructure and Municipal Amenities" under Mtskheta City Hall jointly with Dwellers Cooperatives	2018-2020	1 160	234.4	19 068
RB 2.2	Thermal insulation of common places in the entrances of multi-apartment buildings	NELP "Infrastructure and Municipal Amenities" under Mtskheta City Hall jointly with Dwellers Cooperatives	2017-2020	518	104.6	58 275

Measure RB 3	Sensor Lighting in Entrances					
RB 3.1	Installation of sensor lighting in entrances of multi-apartment buildings	NELP "Infrastructure and Municipal Amenities" under Mtskheta City Hall jointly with Dwellers Cooperatives	2017-2018	75	9.8	3 885
Measure RB 4	Renewable Energy					
RB 4.1	Developing high-efficient bio-waste powered thermal generators for private houses or hotels (for 20 buildings)	NELP "Infrastructure and Municipal Amenities" under Mtskheta City Hall	2018-2025	640	130	12 000
Total				**8 747**	**1 757**	**1 577 463**

5 Street Lighting

5.1 Overview of the Sector

Picture 2. City of Mtskheta at Night

There are 50 streets, 4 squares, central park, 4 small stadiums, and bridges in the City of Mtskheta. All these facilities need illumination. Besides, there is a number of sightseeing in Mtskheta (Svetitskhoveli, Samtavro, Bebris Tsikhe, Jvari Monastery, etc.) having outer lighting. According to the 2015 data, 85% of Mtskheta streets are illuminated.

Compared to 2013, in 2014 the total consumption of the grid has increased by 4.6%, and the average energy efficiency of the grid has grown by 2.2% due to the fact that the newly installed 100 bulbs are energy efficient ones (Table 36).

Table 36. Mtskheta Street Lighting Sector Features in 2013-2014

Year	Number of lanterns (unit)	Annual Consumption of Energy (KWh)	Average efficiency of the Grid (KWh/bulb)
2013	1514	906 793	0.137
2014	1614	948 403	0.134
Change (%)	6.6	4.6	-2.2

In Table 37 the energy consumption by Mtskheta Street Lighting Sector and the expenses in 2014 are given.

Table 37. Energy Consumption and Expenses of Mtskheta Street Lighting Sector in 2014

Infrastructure Facilities	Electric Energy Consumption (KWh)	Financial Expenses (GEL)
Street Lighting of City Mtskheta	948 403	161 228.51
Total	948 403	161 228.51

As it comes from the Table, in 2014 the consumption of electric energy by the City Mtskheta Street Lighting was a bit less than 950 thousand KWh, costing more than 161 thousand GEL. In total, in 2014, 1614 lighting fixtures were installed in the city, the types and the capacities of which are shown in Table 38.

Table 38. Parameters and Features of Mtskheta Public Lighting Bulbs

#	Existing Lighting Fixture	Features	Number
		Capacity, W	
Public Lighting			
1	Eco 20W	20	144
2	Eco 95W	95	546
3	Metal-halogen 150W	150	80
4	Metal-halogen 250W	250	2
5	Metal-halogen 400W	400	31
6	Sodium 70W	70	206
7	Sodium 150W	150	375
8	Sodium 250W	250	188
9	Sodium 400W	400	13
10	Sodium 1000W	1 000	14
11	ДРЛ-250	250	15
	Total		1 614

5.2 Methodology

As it was already mentioned, the number of bulbs in 2014 made up 1614 units and covered 85% of the whole length of streets. As the final goal of the city administration is to illuminate all the existing streets/roads of the city, an assumption was made that in the period of 2016-2018, the streets currently being without lighting will be illuminated gradually so that by 2018 all the streets of the city will have public lighting. In addition, in 2017, in Parnavazi Square, 10 lampions will be installed and each of them will have by three bulbs. Under this scenario/assumption, in total the number of lanterns by 2020 will make 1 929. The capacity of additional bulbs in case of implementation of the BAU, or baseline scenario, is taken based on the average capacity of bulbs existing in 2013 (136W 1 bulb). In the baseline scenario, an assumption was made that the entire grid will be fully equipped with energy-efficient LED lighting fixtures. As well, in 2019-2020 installation of Street Lighting Control System in central districts and streets is planned.

5.3 Base Year (2014) Inventory and GHG Emissions Baseline Scenario (2015-2020) for Street Lighting Sector

In 2014, the consumption of electric energy by Street Lighting Sector made up 0.965GWh.

In 2014, the emissions from Street Lighting equaled to 100.3 t CO_2eq.

The average emission factor for the energy grid in 2014- 0.104 t CO_2/MWh- was taken as the value for electricity emission factor.

According to the baseline scenario, the energy consumption by Street Lighting Sector will grow in future and by 2020 it will make up 1.153 GW/h, and annual emission of CO_2 by 2020 will reach to 119.9 t CO_2eq.

5.4 Emissions Reduction Action Plan for Mtskheta Public Lighting Sector

As it could be seen from Table 39, about 91% of the bulbs existing in the Mtskheta Street Lighting system are inefficient. The Energy Consumption Reduction Action Plan consists of 2 measures**:**

- S1- in 2016-2020 it is planned to substitute all the existing inefficient bulbs with modern LED lamps, as well as, all the added new bulbs will be energy efficient ones;
- S2- in 2018-2020 it is planned to install the Street Lighting control systems in central districts and streets.

Basically, 15, 30, 70 and 110 W LED bulbs will be installed. It is also planned that in 2018-2020 the remote control and economical consumption systems will be arranged at the territory of the city (S2).

In Table 39 the number of existing inefficient streetlights and their effective substitutes by their types, number and capacity are presented.

Table 39. Existing Public Lighting Fixtures and their Energy-Efficient Substitutes by Types and Capacity

	The Lighting Fixtures in the Grid and their Energy Features According to Baseline Scenario 2020				The LED in the Grid and their Energy Features in case of Implementation of Measures			
	Lighting Fixture Type	Number	Capacity W	Total Capacity KW	Lighting Fixture Type	Number	Capacity W	Total Capacity KW
1	Eco 20W	144	20	2.88	LED 15	144	15	2.16
2	Eco95W	546	95	51.87	LED 30	546	30	16.38
3	Metal-halogen 150W	80	150	12	LED 30	80	30	2.4
4	Metal-halogen 250W	2	250	0.5	LED 70	2	70	0.14
5	Metal-halogen 400W	31	400	12.4	LED 110	31	110	3.41
6	Sodium 70W	206	70	14.42	LED 30	206	30	6.18
7	Sodium 150W	375	150	56.25	LED 30	375	30	11.25
8	Sodium 250W	188	250	47	LED 70	188	70	13.16
9	Sodium 400W	13	400	5.2	LED 110	13	110	1.43
10	Sodium 1000W	14	1000	14	LED 110	14	110	1.54
11	ДРЛ-250W	15	250	3.75	LED 70	15	70	1.05
12	Inefficient 136W	315	136	42.97	LED 30	315	30	9.45
	Total	**1 929**		**263.24**		**1 929**		**68.55**

Measure S1: It is implied that implementation of the measure will start in 2016 and the 1 614 inefficient lamps existing by that time will be gradually substituted by the LED bulbs in the period of 2016-2020. In addition, the remaining extent of streets (15% of total length) will be illuminated with efficient bulbs. The total number of lanterns to be substituted is 1 614 / 0.85 + 30 = 1 929 bulbs, or the number of new bulbs makes up 1 929 – 1 614 = 315. If the current energy consumption by one lighting point is at average 0.136KWh and the lighting service is continued with the existing types of bulbs, then by 2020 the energy consumption by the Public Lighting Sector in Mtskheta will equal to 1 929 (lighting fixtures) * 0.136(KW) * 4 380(h) = 1 152 971 KWh, and, if the energy-efficient LED bulbs are used in the entire grid as lighting fixtures, the annual consumption of energy will equal to 1 929 (lighting fixtures) * 0.036(average KW) * 4

380(h) = 300 226KWh. Consequently, in 2020 energy saving will be 1 152 971 – 300 226 = 852 745 KWh electric energy, and, accordingly, emission reduction will equal to 852 745/ 1 000 * 0.104 = 88.69 t CO_2.

As the cost of substitution of one lanterns is about 320 GEL and installation of a new lighting fixture costs about 800 GEL, the value of the measure approximately will be 1 614 * 320 + 315 * 800 = 768 480 GEL, and the saving is 852 745 KWh *0.17 GEL=145 000 GEL per year.

The graph below demonstrates the GHG emissions in case of baseline scenario and in the position of using energy-efficient LED bulbs for Street Lighting spots. This activity is represented as the high priority measure of SEAP in this sector.

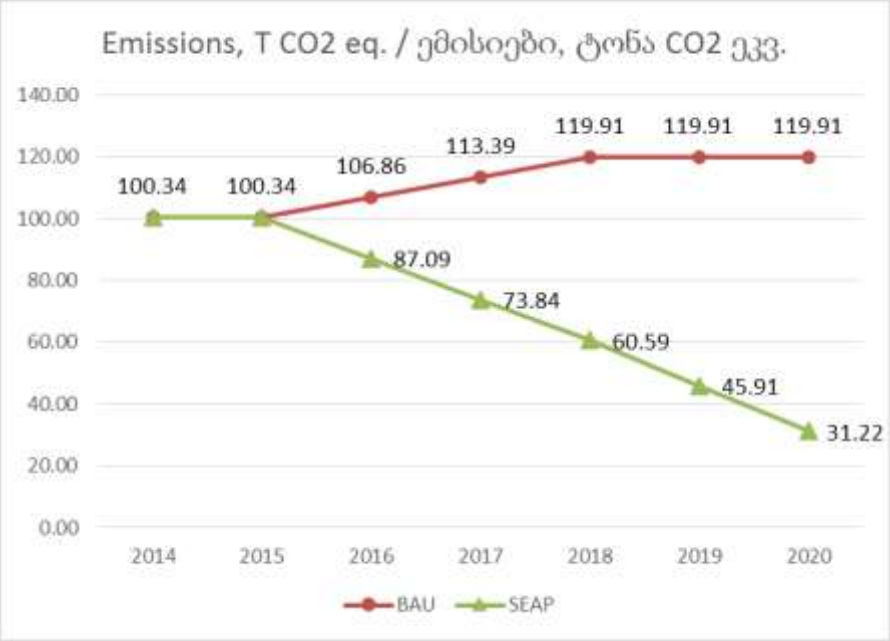

Fig. 11. Emissions from the City's Street Lighting Sector in case of the BAU Scenario and Implementation of S1 Measure according to the SEAP

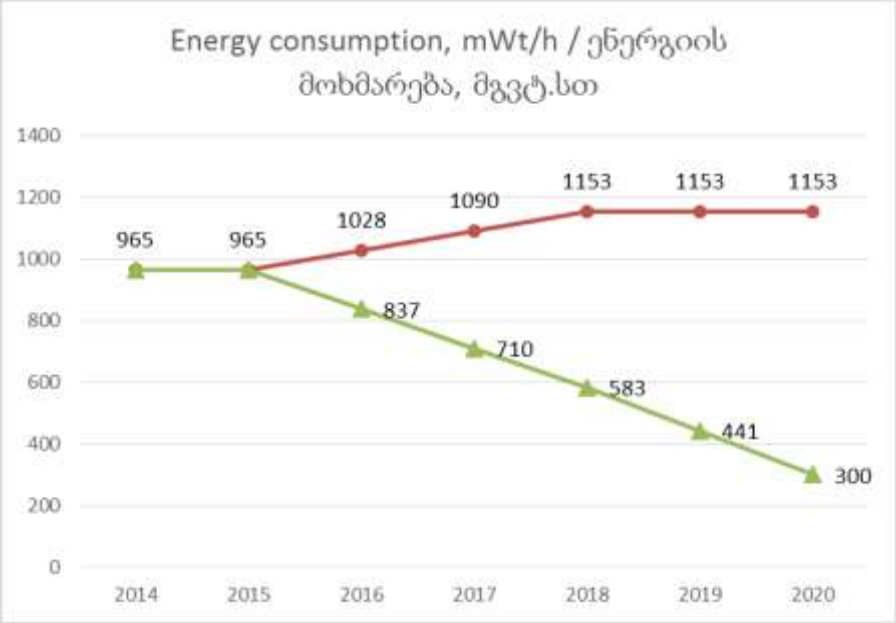

Fig. 12. Energy Consumption in the City's Street Lighting Sector in case of the BAU Scenario and Implementation of S1 Measure according to the SEAP

Thus, in case of implementing measure S1, 853 MW/h energy and 88.69t CO_2 eq. emission will be saved by 2020.

Measure S2: At the territory of Mtskheta City, there the remote control and economical consumption lighting system will be installed. It is implied that the measure will begin after installation of additional bulbs (2016-2018) and will be continued in the period of 2018-2020. During the implementation of this measure, the energy saving will be completed with the help of regulation of Street Lighting system using the remote control equipment. A control point will be arranged for regulating Street Lighting System. In the night hours the lighting will be decreased and every second point will be switched off, etc. It is planned that until 2020, the main streets and districts of City of Mtskheta will presumably be included in the above-mentioned system.

The implementation of similar measure in other countries results in saving of energy consumption at the average by 40-60%.

The graph on Fig. 13 demonstrates emissions reduction in case of baseline scenario, as well as, total reduction of emissions by 2020, in which implementation of first measure (installation of energy efficient lighting fixtures S1) and arranging remote control and economical consumption of lighting system (S2) is considered. Fig. 14 shows the benefits in terms of energy consumption saving in Street Lighting Sector of Mtskheta City, resulting from the implementation of these measures.

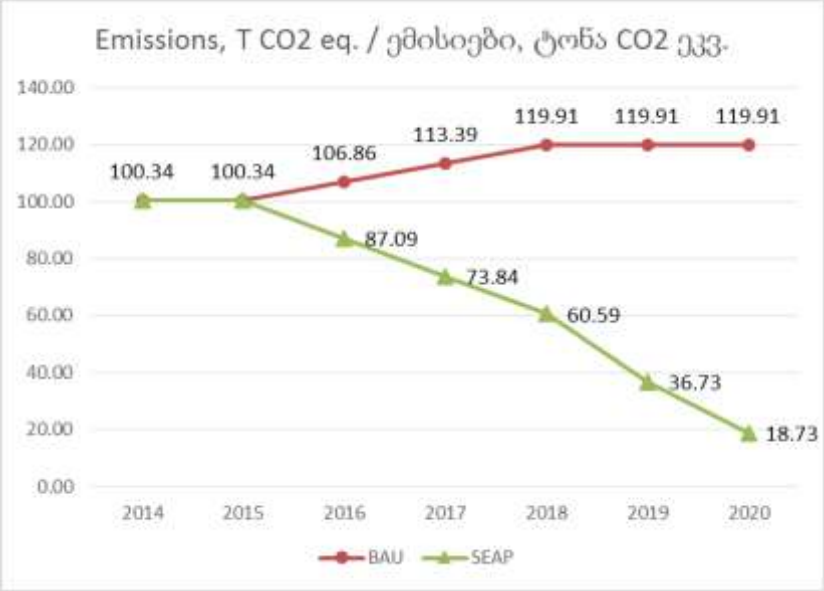

Fig. 13. Emissions from the City's Street Lighting Sector in Case of the BAU Scenario and Implementation of Measures Considered in the SEAP

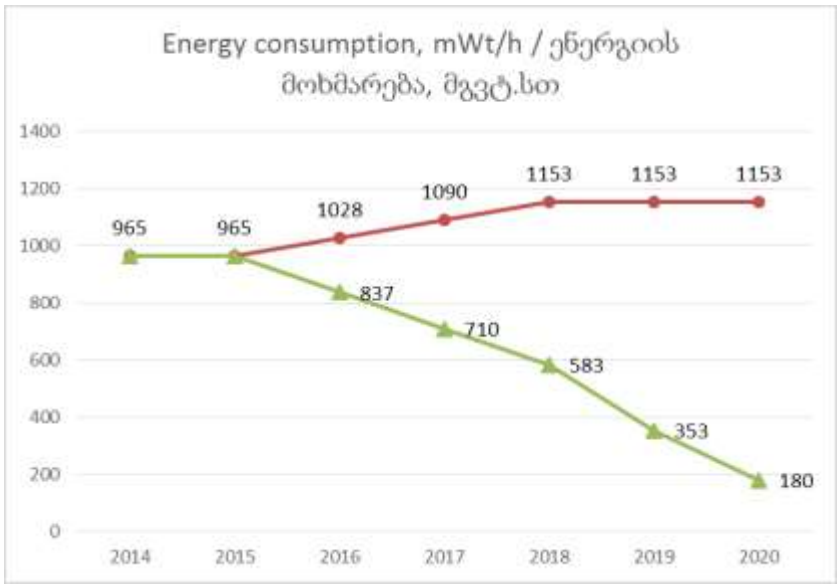

Fig. 14. Energy Consumption in the City's Street Lighting Sector in Case of the BAU Scenario and Implementation of Measures Considered in the SEAP

Table 40. Action Plan for Mtskheta Street Lighting Sector

Sectors and Activity Sphere	Main Measures in the Sphere of Activity	Department/Person or Company in Charge (if the third party is involved)	Implementation Period [start and End Date]	Expected Energy Savings from Each Measure (MWh/y)	Expected CO_2Reduction from Each Measure [t/y]	Cost of Each Measure [in GEL]
Street Lighting S				973	101.17	2 768 480
Energy-efficient Bulbs S1	Increasing the share of energy-efficient bulbs up to 100% within the Street Lighting grid		2016-2020	853	88.69	768 480
Energy-efficient Bulbs S2	Remote Control and Economical Consumption System		2018-2020	120	12.48	2 000 000

6 Greening

6.1 Overview of the Sector

The natural vegetation existing around the City of Mtskheta is rich and diverse. On the hill-sides around the city besides thorn-bushes characterized to steppes (thistles, spirea, shrubberies, savory, almond, wild pear, blackthorn) we also meet forests: starting from oak-and-hornbeam forests and finishing with beech forests on high hill-sides, as well as, from Mtskheta in the direction of Shio Mghvime, mostly on the hillsides of southern exposition we meet Georgian oak, juniper, hornbeam, cornel, etc.

The green cover existing in recreation zones (parks, squares, etc.) and in the homestead plots of the City Mtskheta population is mostly represented with artificially planted perennials.

Development of recreation zones and their landscaping works basically started in the 60s of the last century. At present, the areas covered by perennials occupy different green zones existing within the city, particularly, such areas as the recreation zones (parks, squares, etc.), as well as, the green areas in the homestead plots, areas near the state buildings, along the roads, and cemeteries. In total, the areas within the boundaries of City Mtskheta which are covered by perennial plants makes **258**ha area (see Table 41).

Table 41. Green Zones of Mtskheta Covered with Plantings

№	Green Zones	Areas Covered with Plantings, ha	%
1	Recreation Zones (parks, squares)	25.6	10
2	Greening of different areas in the City (in the homestead plots, areas near buildings, along the roads, etc.)	207.0	80
3	Area on slopes and groves covered by perennials	20.0	8
5	Cemeteries	5.0	2
Total Area Covered by Perennials		257.6	100

The existing natural vegetation and the artificially planted groves around the City Mtskheta are basically at the disposition of Mtskheta Forestry Unit under Mtskheta-Mtianeti Forestry Service. As for the areas covered by perennials existing within the boundaries of the City Mtskheta, which are mostly artificially planted and are represented in fragmented form, are under disposition of the Amenities Services of the City.

The most part of the landscaped areas of the city, (80%) is concentrated in the yards of private residential houses and near different kinds of buildings. In the yards of private residential houses fruit trees are mostly planted.

Table 42. Recreation Zones Existing within the Boundaries of Mtskheta

#	Location of Recreation Zones	Area Covered with Plants m^2	Average Age of the Plants, year	Mostly Spread Species
1	The square adjacent to the building of the Court	340	60-70	Pine
2	The square adjacent to the building of the Union of the Blinds of Georgia branch office	200	60-70	Pine
3	The square adjacent to the building of Furniture Shop	250	60-70	Pine
4	The square adjacent to the building of the Water Management Systems Department	430	40-50	Willow, Lime
5	The square adjacent to the Hero Street	300	60-70	Pine
6	The square adjacent to the House of Culture under construction	2 050	60-70	Pine

7	The square adjacent to Bebris Tsikhe	3 350	50-60	Willow
8	Samtavro Field	10 500	60-70	Pine
9	The square adjacent to the building of City Assembly and the Government Office	1 500	60-70	Pine
10	The squares adjacent to the building of former cinema	1 400	60-70	Cedar
11	Greening adjacent to Central Square	250	60-70	Pine
12	The square adjacent to the Museum building	1 800	50-60	Pine
13	Garden of Culture	3 200	60-70	Pine
14	Greening adjacent to the Monument of Arsena	5 200	50-60	Pine
15	The park adjacent to Tsereteli Street	12 000	60-70	Pine
16	The square adjacent to the building of Education (Educational Resource Center)	860	40-50	Lime
17	Greening adjacent to Theatroni area	202 854	50-60	Poplar
18	The square adjacent to Antoichia Street	10 000	60-70	Pine
	Total	**256 484** **(25.6 ha)**		

The largest recreation zone existing at the territory of City Mtskheta is the 40ha area around Theatroni. The most part of the current recreation zone in the past represented the marshy basin of the River Aragvi. At present, only 20ha of the total area is covered with perennials where mostly dominates poplar, and the remaining area is represented with bushy and grassy covers.

Picture 3. The Recreation Zone Adjacent to Theatroni (Cadastral Code: 72.07.04.975)

The garden, which was laid out by the famous gardener/decorator and honored Art Worker of Georgia Mikheil Mamulashvili (1873-1973), located near Svetitskhoveli Cathedral, should be described separately. Mikheil Mamulashvili started his activities in Mtskheta in the beginning of the last century, in 1907-1908, and first in Mtskheta and later in Narekvavi he arranged greenhouse farms and nurseries of decorative plants. In the same period (in 1908), he started laying out the current garden where he lived. In his garden with total area about 3000 m^2, approximately 1500 different types of exotic and local endemic flowers and perennials were grown. He himself used to bring the plants from different corners of Georgia and abroad, and grew them in the greenhouse existing in the garden. The garden was distinguished with its original landscape planning and beautiful compositions of flowers. Mikheil Mamulashvili was often invited to different cities and resorts of Georgia for greening the recreation zones there.

Unfortunately, at present, the great part of the exotic plants in the garden is destroyed and experience lack of care, the greenhouse is ruined and the compositions created with stones of different shapes and jugs are fallen apart. Mikheil Mamulashvili's living house, which was granted the status of historical monument, is also badly damaged.

NELP "Amenities Services" of Mtskheta Municipality carries out the works of maintenance and care of plants in the green cover areas of Mtskheta: cutting off dry and sick trees, trimming and pruning the trees, digging ground around the trees, and other works. The volume of the wood resource received from cutting off, trimming and pruning the trees reaches about 20m^3 per year (the figure is considered in calculations), and, of course, this volume may be increased due to the damages to trees that may be caused either by natural disaster, or by some other reasons.

As for the greening works, in the recreation zones of Mtskheta City, in 2014-2015 in total, mostly 100 saplings of lime and soap tree have been planted and totally the plantings occupied 1ha area. The mentioned plantings were considered in green zones of the Municipality.

Table 43. Dominant Species in Mtskheta Green Cover

Areas Covered by Perennial Plants	Dominant Species	Average Age	%
Recreation Zones	Pine	50-60	45
	Lime	40-45	15
	Plane tree	40-45	15
	Cedar	50	10
	Cypress	40	5
	Other	-	10
Greening in different areas in the City (in homestead plots, near buildings, along roads, etc.)	Ash tree	35-45	20
	Poplar	50-60	20
	Apple	40	20
	Persimmon	35	15
	Cedar	30-45	10
	Other	-	15
Area on slopes and groves covered by perennials	Apple	5-15	37
	Persimmon	10-15	13
	Walnut	20-50	12
	Plum	10-15	10
	Cherry	5-10	9
	Mulberry	10-20	9
	Other	-	10
Cemeteries	Cypress	30-40	40
	Tuya	20-30	40
	Pine	50-70	10
	Other	-	10

6.2 Methodology

Calculations of Carbon accumulated in green cover of City Mtskheta and its annual accretion in base year (2014) were performed using the Intergovernmental Panel on Climate Change (IPCC) – 2003 methodological guidelines. The calculations were conducted for the so called "live biomass" (including underground biomass). According to the mentioned methodology, accumulated Carbon stock within the perennial plants in green cover of City Mtskheta and the volume of Carbon accretion were calculated.

As for the indexes of some coefficients used in calculations, as the perennial arboreal plants in green zones of the city are represented only in fragmented forms, in calculations were used the corresponding indexes for this type of seedlings, which are different from those of the closed canopy seedlings. To identify the corresponding indexes of the perennial plants presented in the Municipality's green zones (which are mainly represented in fragmented form), specific data for these plants was used, like their wood stocks data (average age 50 years), and the different relevant scientific sources, for example, Tables of Growth Rates and Stocks[13], etc. As a result, the average index has been obtained, which allows the approximate assessment of wood stock (40m^3) at 1ha area of fragmented greening.

As it was already mentioned, the perennial arboreal plants are represented only in fragmented forms in the city's 257.6ha of green cover. Therefore, emissions factors typical for the respective type of green cover were used for calculations. It should be noted that in accretion coefficient used in calculations the factor of planting trees in green zones of town in 2014-2015 has been taken into account, resulting the adjustment of accretion factor towards the growth rate.

More specifically, in calculations based on the taxation materials the data on average annual accretion and wood stocks of plants were used. And, to obtain the average wood volume weight (D) index the data on absolutely dry wood volume weight for dominant arboreal plants were used, which was taken from different scientific sources. The values of other parameters (BEF_1, BEF_2, R, CF) were taken from Tables attached to the IPCC Guidelines, particularly, from the list of standard indexes typical for the region's climate conditions.

As for the Carbon accumulation potential resulting from the planned measures, the model CO2FIX has been used for its assessment. According to the scenario considered in the project (planting of greenery), two computing modules were used for calculations, namely: the biomass and soil modules.

6.3 Base Year (2014) Inventory and Carbon Dioxide Sequestration Baseline Scenario (2014 – 2030)

Calculation Outcomes

The calculation outcomes of the accumulated Carbon at City Mtskheta territory in Base Year 2014 are given in Table 44, and the values of annual accretion – in Table 45.

Table 44. Carbon Stocks Accumulated at Green Cover Area of Mtskheta in Base Year (2014)

[13] Forestry Taxation Directory, V. Mirzashvili, G. Kuparadze

Plants in Green Zones	Area, ha	Stock, M^3/ha	D	BEF_2	(1+R)	CF	Total Carbon Stock, tC
2014							
Fragmented Covered Plants	257.6	40.0	0.49	1.30	1.24	0.50	4 069.5

Table 45. Annual Accretion of Carbon at Green Cover Area of Mtskheta in Base Year (2014)

Green Cover	Area, ha	Stock, M^3/ha	D	BEF_2	(1+R)	CF	Total Carbon Stock, tC
2014							
Covered Fragmentally	257.6	1.7	0.49	1.15	1.24	0.50	153

In the baseline scenario (2014-2030) of Carbon stocks accumulation at City Mtskheta planted areas, the index of annual accretion of Carbon in the biomass has been taken into account, resulting from assessment of carbon stocks' expected potential (see Table 46), which could be changed in the future due to different reasons of biomass decrease (biotic or abiotic).

Table 46. Carbon and, Consequently, Carbon Dioxide Sequestration Base Scenario (2014-2030)

		Annual Sequestration							
		2014	2015	2016	2017	2018	2019	2020	2021
1	Annual of Sequestration Carbon, tC	4 069.5	4 222.5	4 375.5	4 528.5	4 681.5	4 834.5	4 987.5	5 140.5
2	Annual Sequestration of removal of Carbon Dioxide, thousand tCO_2	14 921.5	15 482.5	16 043.5	16 604.5	17 165.5	17 726.5	18 287.5	18 848.5
Annual Sequestration									
	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	5 293.5	5 446.5	5 599.5	5 752.5	5 905.5	6 058.5	6 211.5	6 364.5	6 517.5

2	19 409.5	19 970.5	20 531.5	21 092.5	21 653.5	22 214.5	22 775.5	23 336.5	23 897.5

6.4 Measures for Increase of Carbon Dioxide Removal by Mtskheta Greening Sector

According to the Action Plan, since 2015-2016 greening activities in different recreation zones of Mtskheta have been started, particularly, as a result of the mentioned works, in total there were planted 2000 pieces of lime and soap trees and finally the area occupied by plants reached 1ha. For the next few years, planting the trees in green zones existing within the boundaries of the city, is also planned namely, it is considered as the priority to arrange a recreation zone and forest-park at 20ha less-planted area adjacent to Theatroni.

As it was already mentioned, within the frames of the Action Plan measures, namely, after setting out the plantings at the landscaped areas the Carbon accumulation potential has been assessed using the model CO2FIX.

Planned Measure G1. As it was said above, in 2015-2016 in different recreation zones of Mtskheta were planted 2000 pieces of lime and soap trees (Table 47). The area occupied by plants makes 1ha.

Table 47. Plantings laid out in Mtskheta (1ha) in 2015-2016

Planted Arboreal Plants	Number of Planted Saplings, pieces	Age of Saplings
Lime, Soap Trees	2 000	5-6

At present, almost 100% of the planted saplings have taken roots. Following the measure the expected Carbon accumulation potential has been assessed using the model CO2FIX, and calculation outcomes are given in Table 48.

Table 48. Annual Accumulation Indexes of the Laid out Plantings (1ha)

	2015	2016	2017	2018	2019	2020	2021
Carbon Accumulated, tC	1.99	3.93	5.90	7.86	9.83	11.81	13.79
Annual Carbon Dioxide sequestration, tCO_2	7.30	14.41	21.63	28.82	36.04	43.30	50.56

2022	2023	2024	2025	2026	2027	2028	2029	2030
15.78	17.76	19.75	21.73	23.70	25.66	27.61	29.55	31.47
57.86	65.12	72.42	79.68	86.90	94.09	101.24	108.35	115.39

Planned Measure G2. In 2016-2030 it is planned gradually to arrange (greening and arranging infrastrucutre at 1.33ha area per year) recreation zone, at the 20ha area adjacent to Theatroni. In total, laying out the plants is considered for 15ha area, and on the remaining 5ha area there will be arranged different types of infrastructure (roads, paths, lawns, etc.)

Selection of seedling material assortments for the project territory plays an important role. While designing the territory to be greened the most important moment is correct selection of the species of trees and shrubs. Selecting arboreal species requires foreseeing the environmental conditions of the location where they will be planted, for example, what kind of soil, climate conditions and slope exposition are there, and the potential of carbon dioxide removal by the arboreal plants.

Considering the above-mentioned criteria, several arboreal plants have been selected for planting: poplar, maple, lime, Paulownia, grove oak, willow, mulberry, Tuya, Lugustrum). We should also mention here that near the river, where the groundwater level is high, it is reasonable to plant poplar, different types of willows, and grove oak (Table 49).

During planning the planting it is considered to plant mixed species of arboreal plants, which has a big advantage compared to pure species of plants. The mixed plantings are more resistant to wind, less affected by insects and fungus parasites, and comparatively well-resistant to unfavorable climate conditions.

During landscape planning of forest-parks it is urgent to arrange different decorative landscapes, as there are: alleys, small groves, squares with green grass and evergreen curbs, etc.

For 1ha area of the project territory, it is planned to lay out 3000 pieces of trees and shrubs. In total, for greening 15ha area, there will be needed 45000 pieces of different species of arboreal plants. For expenditure values of arranging infrastructure at 5ha area of the project territory (walking paths, squares, curbs and other kind of infrastructure) have been taken the respective expenditure values of arranging squares in different cities of Georgia (for example: Gori, Kutaisi).

Table 49. List of Perennial Plants Appropriate for the Planned Greening in Mtskheta in 2016-2030

List of Saplings Planned for Planting	Number of Saplings, pieces	Age of Saplings
Trees Planned for Planting at 1ha area Around the City		
Poplar	350	4-10 year
Grove Oak	300	
Willow	500	
Paulownia	350	
Maple	200	
Lugustrum (different decorative shapes)	500	
Tuya	500	
Total:	3 000	

During landscape planning, especially in terms of squares and roads, it is reasonable the planting material of arboreal plants to be at least 7-10 years old, with the shaped crown and already developed and healthy system of roots; Hence, at the project territory a forest-park with the functional capacity of recreation zone may be formed earlier.

As a result, after laying out the forest-park, especially in the zones suitable for forest landscape, a perfectly featured carbon accumulation pool may be obtained, in which soils will be engaged in carbon sequestration process and the city will acquire green zone comparable to valuable forest ecosystem.

It should be noted that to implement the activities within the project territory it is urgent to develop a landscaping project, the necessary components of which are: schematic maps of arranging planting and infrastructure utilities, list of the greenery selected for planting and budget of all scheduled activities. In Table 50 the presumable expenditures are given necessary to implement the planned measures at the project territory.

Table 50. Calculation of Greening 1 ha Park Area near Theatroni and, additionally, 0.33ha Area Arrangement Activities

#	Description of Expenditures	Unit	Cost of Unit (US $)	Total Amount	Total Cost (US $)
I. Core Expenses					
1.	**Field Activities**				
1.1	Cleaning up the Area (from shrubs, sprouts, etc.)	ha	150.0	1	150.0
1.3	Marking the Area and Digging out Pits	Sapling/ Piece	0.09	3 000	270
1.4	Purchasing Saplings	Sapling/ Piece	7.0	3 000	21 000
1.6	Planting Saplings	Sapling/ Piece	0.13	3 000	390
1.7	Watering Saplings	Sapling/ Piece	0.10	3 000	300
1.8	Arranging infrastructure	m^2	10	3 330	33 300
	Total sum (USD)				**55 410**

Indexes of carbon sequestration after laying out the plants at 1ha area are given in Appendix III, Table 73, and carbon accumulation at 15ha area is given in Table 51.

Table 51. Indexes of Annual Carbon Accumulation in the Laid out Plantings on 15ha Area

Year		2016	2017	2018	2019	2020	2021	2022	2023
		1	2	3	4	5	6	7	8
Accumulated Carbon, tC	2016	3.28	6.10	8.67	11.23	13.80	16.38	18.97	21.55
	2017		3.28	6.10	8.67	11.23	13.80	16.38	18.97
	2018			3.28	6.10	8.67	11.23	13.80	16.38

	2019				3.28	6.10	8.67	11.23	13.80
	2020					3.28	6.10	8.67	11.23
	2021						3.28	6.10	8.67
	2022							3.28	6.10
	2023								3.28
Total Annual Accumulation, tC		**3.28**	**9,38**	**18,05**	**29,28**	**43,08**	**59,46**	**78,43**	**99,98**
Carbon Dioxide Annual Sequestration, tCO_2		**12.03**	**34.40**	**66.18**	**107,36**	**157,96**	**218,02**	**287,58**	**366.60**
Year		2024	2025	2026	2027	2028	2029	2030	
		9	10	11	12	13	14	15	
Annual Accumulated Carbon, tC	2016	24.13	26.72	29.28	31.84	34.38	36.90	39.41	
	2017	21.55	24.13	26.72	29.28	31.84	34.38	36.90	
	2018	18.97	21.55	24.13	26.72	29.28	31.84	34.38	
	2019	16.38	18.97	21.55	24.13	26.72	29.28	31.84	
	2020	13.80	16.38	18.97	21.55	24.13	26.72	29.28	
	2021	11.23	13.80	16.38	18.97	21.55	24.13	26.72	
	2022	8.67	11.23	13.80	16.38	18.97	21.55	24.13	
	2023	6.10	8.67	11.23	13.80	16.38	18.97	21.55	
	2024	3.28	6.10	8.67	11.23	13.80	16.38	18.97	
	2025		3.28	6.10	8.67	11.23	13.80	16.38	
	2026			3.28	6.10	8.67	11.23	13.80	
	2027				3.28	6.10	8.67	11.23	
	2028					3.28	6.10	8.67	
	2029						3.28	6.10	
	2030							3.28	
Total Annual Accumulation, tC		**124.11**	**150.83**	**180.11**	**211.95**	**246.33**	**283.23**	**322.64**	
Carbon Dioxide Annual Sequestration, tCO_2		**455.07**	**553.04**	**660.40**	**777.15**	**903.21**	**1038.51**	**1183.01**	

In Table 52, there are given Carbon accumulated in green cover of City Mtskheta and annually sequestered Carbon Dioxide both without implementation of measures and in case of their implementation.

Table 52. Carbon Accumulation Potential after Greening according to Base Year 2014 and Action Plan

		Annual Accumulation of Carbon, tC						
		2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
1	Accumulation of Carbon in Green zones (without implementation of measures)	**4 069.5**	**4 222.5**	**4 375.5**	**4 528.5**	**4 681.5**	**4 834.5**	**4 987.5**
2	Accumulation of Carbon as a result of greening different green zones of the city after laying out plants (1ha) in 2015-2016	-	1.99	3.93	5.90	7.86	9.83	11.81
3	Accumulation of Carbon resulting from greening 15 ha area at the territory of Theatroni	-	-	**3.28**	**9.38**	**18.05**	**29.28**	**43.08**
4	Total	**4 069.5**	**4 224.5**	**4 382.7**	**4 543.8**	**4 707.4**	**4 873.6**	**5 042.4**
5	Equivalent in t CO_2	**14 921.5**	**15 489.8**	**16 069.9**	**16 660.6**	**17 260.5**	**17 869.9**	**18 488.8**

	Annual Accumulation of Carbon, tC									
	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
1	**5 140.5**	**5 293.5**	**5 446.5**	**5 599.5**	**5 752.5**	**5 905.5**	**6 058.5**	**6 211.5**	**6 364.5**	**6 517.5**
2	13.79	15.78	17.76	19.75	21.73	23.70	25.66	27.61	29.55	31.47
3	**59.46**	**78.43**	**99.98**	**124.11**	**150.83**	**180.11**	**211.95**	**246.33**	**283.23**	**322.64**
4	**5 213.7**	**5 387.7**	**5 564.2**	**5 743.4**	**5 925.1**	**6 109.3**	**6 296.1**	**6 485.4**	**6 677.3**	**6 871.6**
5	**19 116.9**	**19 754.9**	**20 402.1**	**21 059.1**	**21 725.4**	**22 400.8**	**23 085.7**	**23 779.8**	**24 483.4**	**25 195.9**

Table 53. Action Plan for the City Greening Sector

Activity	Planned Measures	Responsible Body	Implementation period (Start and End Dates)	Expected CO_2 Reduction from Each Measure(t) by 2020	Expected CO_2 Reduction from Each Measure(t) by 2030	Cost of Each Measure (GEL)
1	2	3	4	5	6	7
G				201.3	1 298.3	2 614 270
G1	The plantings (1ha) laid out in different green zones of the city	NELP "Amenities Services" of Mtskheta Municipality	2015-2016	43.3	115.4	10 000
G2	Arranging forest-park at 20ha area adjacent to Mtskheta Theatroni	NELP "Amenities Services" of Mtskheta Municipality	2016-2030	158.0	1 182.9	2 604 270

7 Waste

7.1 Overview of the Sector

On June 15, 2014, local self-government elections were held in the City of Mtskheta and for the first time in its history, Mtskheta became a self-governing city[14]. Yet, in the 90s of the last century City of Mtskheta was declared as a "City Museum" and local landfill was closed. Since that time, the city-wide produced waste is disposed at the landfill located at 7.5ha area on the territory of village Akhtala, Kaspi Municipality[15], which is not under jurisdiction of Mtskheta Municipality. Maintenance of Kaspi landfill is the responsibility of the Central Government and since 2013 it has been managed by "Solid Waste Management Company". By 2014, the arrangement of Kaspi landfill was completed as a result of which the waste disposed at the landfill is covered with ground and rammed by tractor but up to now, the landfill does not have any drainage waters and landfill gas collecting systems. Waste management in the whole City Mtskheta is carried out by the Territorial Cleaning Service of the Self-governing City Mtskheta Municipality Amenities Services[16]. The responsibility of the mentioned Cleaning Service includes collection of the household waste produced by the entire population of City Mtskheta and disposing at Kaspi landfill. Annually, from Mtskheta Municipality about 2 400 - 3 200 t solid household waste is collected.

7.2 Methodology and the Included Parameters

To calculate emissions from Waste Sector the guidelines of Intergovernmental Panel on Climate Change (IPCC) developed by the United Nations Framework Convention on Climate Change (UNFCCC) were used, under the principles of which this sector covers emissions based on the following source-categories:

- Solid Waste Disposal (6A)
- Wastewater Treatment (6B1 , 6B2)
- Waste Incineration (6C)
- Other Waste – Industrial, Medical and Radioactive (6D)

A Waste Sector inventory for City of Mtskheta was conducted for two source-categories only: "Disposal of Solid Waste" (6A) and "Household and Commercial Wastewater Treatment (6B1). Sub-category "Industrial Wastewaters" (6B2) is not considered as there are no large industrial enterprises in City Mtskheta Municipality. As well as, the IPCC source-categories "Waste Incineration" and "Other Waste" are not considered as in City Mtskheta no waste is incinerated and Other Waste (industrial, medical, and radioactive waste) is not recorded and collected at the site.

There are two ways to calculate methane emissions from landfills, suggested by the IPCC guidelines: (1) "Typical Default Method", - methodological approach Tier 1, and "First Order Decay Method" (FOD) – methodological approach Tier 2. The main difference between these two methods is that FOD method gives a time-dependent profile of emissions production that better reflects waste degradation processes, while the typical default method is based on the assumption that complete methane production potential, as well as emissions of the generated methane, occur in the year of disposal. The "Typical Default Method" result is satisfactory if there is a permanent amount and composition of waste disposed at a landfill, or if the variations are insignificant over several decades. However, if there are important changes in the amount and

[14] http://mtskheta.gov.ge/ge/City of Mtskheta/History
[15] http://nala.ge/uploads/kaspi.pdf
[16] http://nala.ge/uploads/mcxeta.pdf

composition of waste in the country/region, that, naturally, causes changing Carbon level in the waste, then the use of the "Typical Default Method" is not recommended.

To calculate methane emission from waste generated from City Mtskheta Waste Sector "First Order Decay Method" (FOD, Tier 2) has been applied and the relevant formula and parameters are given in the box below[17].

Tier 2: "First Order Decay Method" (**FOD**)

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T \right] \cdot (1 - OX_T)$$

Where:

Σ $CH_{4generated x,T}$ – is amount of methane generated, equal to CH_4 $generated_T$ = DDOCm $decomp_T$ • F •16 /12, where (DDOCm $decomp_T$ – is decomposed mass (DDOCm) of degradable organic carbon (DOC) , that will decompose in year T, Gg; F – fraction of methane in landfill gas; 16/12 - CH_4/C is ratio between molecular masses)

$CH_{4\ Emissions}$ - emitted into the atmosphere CH4 Gg, in the year *T*;

T – year of inventory;

x – fraction of waste/composition;

RT - collected from the landfill and rendered harmless CH4 Gg, in the year *T*;

OXT - Oxidation factor in the year *T*.

Activity Data

Population which generates the waste that is delivered, or was carried to the landfills[18]

According to Mtskheta City Hall, household waste collection and delivering is carried out from the entire population of the city. In 2014, the number of City Mtskheta population made 7 940[19], that is 13.8% of Mtskheta Municipality population (Mtskheta Municipality population - 57 400 (2014)[20]), and, in 2015, according to information of Mtskheta City Hall, the conducted population census revealed that the population of City Mtskheta made 9 800 (**Error! Reference source not found.**). The tourist flow also has significant impact on the solid household waste production in Mtskheta at city-wide level. The statistics of City Mtskheta and Mtskheta Municipality population for 2012-2015 is given in Table 54[21].

Table 54. Population of Mtskheta and the Mtskheta Municipality, thousand Men [22]

[17] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

[18] http://lemill.net/content/webpages/10e5-10e410dd10d710d810e1-10d310d410db10dd10d210e010d010e410d810d0/view

[19] https://ka.wikipedia.org/wiki/Mtskheta

[20] http://geostat.ge

[21] Mtskheta City hall

[22] http://geostat.ge

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Thousand men	City Mtskheta	8.82	8.86	9.00	8.97	6.42	6.42	7.85	7.91	7.95	7.91	7.94	9.80
	Mtskheta Municipality	63.9	64.2	65.2	65.0	46.5	46.5	56.9	57.3	57.6	57.3	57.4	-

The forecast for number of population by 2020 was done considering all the assumptions of the SEAP, or 0.5% growth per year, and the forecast for growth of the visitors' flow was made based on the statistical dynamics in 2012-2016 (15% per year), provided by Mtskheta City Hall.

Characteristics of Waste Generation and Disposition Processes

According to the City Hall information, there are no illegal dumps in City Mtskheta and 100% of the solid household waste (SHW) produced throughout the city (by population, commercial and state facilities) is disposed at Kaspi landfill. As a result of the studies conducted in Mtskheta-Mtianeti Region during 2015[23], it was identified that the average annual amount of the waste produced by population, commercial and state facilities makes 270.45kg per capita, to this, the same survey made in 2015-2016 throughout Georgia revealed that the amount of waste produced by visitors arriving in Georgia average makes 150kg/per capita/yr (Table 55).

Table 55. Visitors of Mtskheta and Household Waste Produced by them

Year	Visitor	Amount of Waste Produced by Visitors		
		kg/person/day	kg/yr	Gg/yr
2012	90 000	0.40	36 437.01	0.04
2013	100 000	0.41	40 687.99	0.04
2014	110 000	0.41	44 980.58	0.04
2015	130 000	0.41	53 424.66	0.05
2016	160 000	0.41	66 082.19	0.07

As it was mentioned above, for the following years as the forecasted growth of solid household waste amount from population per capita was taken 0.5% per year, and from visitors – 2.5% per year.

Waste Composition

The information on solid residential waste at country-wide level in Georgia is very poor and until 2015 it was limited only with the existing data on solid household waste composition produced on the territories of

[23] Project funded by Shota Rustaveli National Science Foundation and implemented by Institute of Hydrometeorology of Georgian Technical University on "Developing the Methodology for Identifying the Amount of the Solid Household Waste Generated in Georgia and Its Morphological Composition, and Creating the Database"

Tbilisi, Telavi and Batumi. To resolve this problem, in May 2015 the Project funded by Shota Rustaveli National Science Foundation started and is implemented by the Institute of Hydrometeorology of Georgian Technical University on "Developing Methodology to Identify the Amount of the Solid Household Waste Generated in Georgia and Its Morphological Composition, and Creating the Database". The information obtained within the frames of the project on composition of waste produced by City Mtskheta is given in Tables (Table 56 and Table 57). The data on composition of waste produced by Mtskheta were also used in calculation for 2012-2030.

Table 56. Composition of Solid Household Waste Produced by Mtskheta (2015)

Waste Fraction	Organic Waste	Paper/Cardboard	Wood	Textile/Leather	Hygiene Waste	Plastic/Inert Material	Total
By mass %	43.89	9.93	0.67	1.81	5.92	37.78	100

Table 57. Composition of Solid Household Waste Produced by the Visitors in Georgia (2015-2016)

Waste Fraction	Organic Waste	Paper/Cardboard	Wood	Textile/Leather	Hygiene Waste	Plastic/Inert Material	Total
By mass %	44.64	26.73	0.50	0.10	2.45	25.58	100

Emission Factors

Different emission factors are used in the process of calculation of methane emission from solid waste:

Methane Correction Factor – MCF

MCF depends on the landfill type – unmanaged landfills produce less methane than managed ones because decomposition of most waste in the upper layer occurs in aerobic or Oxygen-containing conditions and releases Carbon Dioxide. The IPCC 2006[24] gives typical default values of this factor which are presented in Table 58.

Table 58. Typical Default Values of Methane Correction Factor (MCF) for Different Types and Kaspi Landfills

Type of Landfill/Landfill	**MCF**
Managed[25]	1.0
Managed - thin (waste thickness <5m)[26]	0.5
Unmanaged - deep (waste thickness>5m)	0.8

[24] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf (pg. 3.14)

[25] A managed landfill implies the disposal area kept under control (waste is placed at specially prepared places where the waste is "blown" and is controlled against self-flaring). At the same time the waste is covered, rammed and layered. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000, pg. 5.9

[26] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (pg.3.16)

Unmanaged – thin (waste thickness<5m)	0.4
Uncategorized Landfill	0.6
Official Landfill of Kaspi (1980-1992)	0.4
Official Landfill of Kaspi (1993-2013)	0.8
Official Landfill of Kaspi (2014-2030)	1

As of now, at the Kaspi landfill, where City Mtskheta-produced waste is disposed, the thickness of waste is more than 5meters. The landfill started operation close to the standards since 2014, hence, considering values given in Table 58, for calculation of the methane emissions correction factor equals to: in 1980-1992 - 0.4 (Unmanaged-thin), from 1993 till the end of 2013 – 0.8 (Unmanaged-deep), 2014 -2030 – 1 (Managed)[27].

Degradable Organic Carbon - DOC

Degradable Organic Carbon (DOC) is the organic Carbon in waste, which is decomposed biochemically and measured in GgC/Gg of waste.

Value of the DOC depends on waste composition and country/region climate conditions. To calculate the value of the DOC for waste components the IPCC 2006 methodology[28] was used. The values of the DOC according to waste composition are given in Table 59.

Table 59. DOC Value According to Waste Composition

Waste Fractions	Food waste	Garden	Paper	Wood and Straw	Textiles	Disposable diaper
Value of DOC	0.15	0.20	0.40	0.43	0.24	0.24

Fraction of Degradable Organic Carbon Dissimilated-DOC_F

The DOC_F is actually a dissimilated component of organic Carbon. A certain part of organic Carbon is not decomposed at all, or is decomposed very slowly. The IPCC GPG 2000 recommends for DOC_F the value 0.5-0.6 (in this case, it is assumed that the landfill is in anaerobic conditions and lignin[29] carbon is included in the DOC value). The DOC_F value depends on a number of factors such as air temperature and moisture, pH, waste composition, etc.

IPCC GPG recommends for the DOC_F to use national values though they should be based on well-documented surveys.

[27] Unorganized dumps are those small size areas where is gathered the scattered waste and where anaerobic processes don't take place.

[28] http://www.ipcc-nggip.iges.or.jp/public/2006gl (pg. 2.16)

[29] Plant cell consists of three important components: cellulose, lignin and hemicellulose. Lignin strengthens cell walls, binding the latter as well. Dissimilation of lignin is anaerobic process; lignin becomes durable under anaerobic conditions

Methane Content of Landfill Gas (F)

Methane concentration in landfill gas is up to 50% according to the IPCC 2006. Only oil and fat containing materials generate bio gas with more than 50% of methane content.

Oxidation Factor (OX)

Oxidation factors reflect the amount of methane generated in waste cover materials (soil, etc.). OX value in case of managed landfill (where waste is covered by oxidizing materials – soil, compost) is equal to 0.1, for unmanaged dumps it is amounting to OX=0[30]. This volume 0 has thus been taken for the City Kaspi landfill.

7.3 Base Year Inventory and the GHG Emissions Baseline Scenario (2014-2030) for Waste Sector

Growth of City Mtskheta population, improving their living level and increase of tourist number promotes growth of solid household waste (Table 60 resulting growth of Methane emission from Waste Sector in the atmosphere.

Table 60 shows the forecast of Methane emissions from City Mtskheta Waste Sector.

Table 60. Base Scenarion 2014-2030 of CO_2 Emission from Waste Sector in Mtskheta Municipality

Year	CH_4. t			CO_2 eq Gg
	Population	Visitors	Total	
2012	62.01	0.77	62.78	1.32
2013	63.80	0.89	64.69	1.36
2014	68.02	1.08	69.1	1.45
2015	72.04	1.28	73.32	1.54
2016	78.89	1.52	80.41	1.69
2017	85.29	1.82	87.11	1.83
2018	91.33	2.16	93.49	1.96
2019	97.09	2.55	99.64	2.09
2020	102.63	2.99	105.62	2.22
2021	107.99	3.49	111.48	2.34
2022	113.24	4.07	117.31	2.46
2023	118.39	4.73	123.12	2.59

[30]. http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html (pg.5.10)

2024	123.5	5.5	129	2.71
2025	128.57	6.38	134.95	2.83
2026	133.65	7.4	141.05	2.96
2027	138.75	8.57	147.32	3.09
2028	143.89	9.92	153.81	3.23
2029	149.08	11.49	160.57	3.37
2030	154.34	13.29	167.63	3.52

The amount of waste produced by visitors in 2016 makes 2.5% of total amount of waste, and consequently, by 2020 it will be 3.76%, and by 2030 it will reach 10.78%.

The amount of Methane emissions from waste produced by visitors of City Mtskheta in 2016 makes 1.89% of total amount of Methane emissions, and consequently, according to forecast, by 2020 it will be 2.83%, and by 2030 it will reach 7.93%.

7.4 Action Plan for Emissions Reduction from Solid Waste Subsector of Mtskheta Municipality

In compliance with the "National Waste Management Action Plan 2016-2020" and "National Waste Management Strategy 2016-2030", in all the regions of Georgia before disposition of solid household waste at landfill it is planned to conduct separation of some fractions (paper, plastic, metal and glass) aimed at further processing. As a result of mentioned activities the amount of paper, plastic, metal and glass fractions will be reduced in waste and, consequently, their decomposition will result in reduction of the amount of gas emissions (among them of Methane) in the atmospheric air.

Mtskheta Municipality plans to start sorting the waste on the spot in the nearest future. At this stage, to identify the Methane emission from City Mtskheta Municipality Waste Sector in compliance with the "National Waste Management Action Plan 2016-2020" and "National Waste Management Strategy 2016-2030" and based on this document, the following assumptions[31] were made:

- During 2017, 5% separation of paper will be conducted and by 2020 it will reach 30% and by 2030 – 80%;
- During 2017, 5% separation of glass will be conducted and by 2020 it will reach 20% and by 2030 – 80%;
- During 2017, 5% separation of metal will be conducted and by 2020 it will reach 70% and by 2030 – 90%;
- During 2017, 5% separation of plastics will be conducted and by 2020 it will reach 30% and by 2030 – 80%;

[31] National Waste Management Action Plan 2016-2020 https://matsne.gov.ge/ka/document/view/3242506 , Goal 5, Task 5.2

After implementation of the measures in compliance with the "National Waste Management Action Plan 2016-2020" and "National Waste Management Strategy 2016-2030", the amount of solid household waste disposed at the landfill will be reduced at 10.42% by 2020, and at 21.54% - by 2030, and in case of visitors, by 2020 – at 25%, and by 2030 – at 55.26% (Table 61).

As it could be derived from Table 61, after taking the measure, the projected amount of Methane emissions from waste produced by the visitors of City Mtskheta by 2020 will be accordingly 3.17% and by 2030 it will reach only 5.18%.

Table 61. Forecast for Solid Household Waste (SHW) Amount Produced by Mtskheta Population and its Visitors

Year	Amount of SHW, Gg						Reduction of SHW after the Measure %		Saved SHW, Gg
	Without Implementation of Measure			With Implementation of Measure					
	Population	Visitor	Total	Population	Visitors	Total	Population	Visitors	
2015	2.65	0.05	2.70	2.65	0.05	2.70	0.00	0.00	0.00
2016	2.73	0.07	2.80	2.73	0.07	2.80	0.00	0.00	0.00
2017	2.81	0.08	2.89	2.77	0.07	2.84	1.42	12.50	0.04
2018	2.90	0.09	2.99	2.77	0.08	2.85	4.48	11.11	0.14
2019	2.98	0.10	3.09	2.76	0.09	2.85	7.38	10.00	0.24
2020	3.07	0.12	3.19	2.75	0.09	2.84	10.42	25.00	0.35
2021	3.17	0.14	3.30	2.79	0.10	2.90	11.99	28.57	0.40
2022	3.26	0.16	3.42	2.84	0.11	2.95	12.88	31.25	0.47
2023	3.36	0.18	3.54	2.89	0.12	3.01	13.99	33.33	0.53
2024	3.46	0.21	3.67	2.93	0.13	3.07	15.32	38.10	0.61
2025	3.57	0.24	3.81	2.98	0.15	3.12	16.53	37.50	0.69
2026	3.67	0.28	3.95	3.01	0.15	3.16	17.98	46.43	0.79
2027	3.78	0.32	4.11	3.03	0.16	3.19	19.84	50.00	0.91
2028	3.90	0.38	4.27	3.06	0.17	3.23	21.54	55.26	1.05
2029	4.02	0.43	4.45	3.08	0.17	3.25	23.38	60.47	1.19
2030	4.14	0.50	4.64	3.11	0.17	3.28	24.88	66.00	1.36

In Tables (Table 62 and Table 63) the forecast of Methane emissions reduction by 2020 and 2030 is given.

Table 62. Forecast for Methane Emission from Mtskheta Waste Sector in Case of Implementation of Measures

Year	CH_4. t			CO_2 eq, Gg
	Population	Visitor	Total	
2012	62.01	0.77	62.78	1.32
2013	63.80	0.89	64.69	1.36
2014	68.02	1.08	69.11	1.45
2015	72.04	1.28	73.32	1.54
2016	78.89	1.52	80.41	1.69
2017	85.29	1.82	87.11	1.83
2018	91.20	2.15	93.35	1.96
2019	96.62	2.51	99.13	2.08
2020	101.58	2.90	104.47	2.19
2021	106.15	3.26	109.41	2.30
2022	110.50	3.65	114.16	2.40
2023	114.67	4.07	118.74	2.49
2024	118.69	4.50	123.19	2.59
2025	122.57	4.96	127.53	2.68
2026	126.35	5.44	131.79	2.77
2027	129.97	5.93	135.90	2.85
2028	133.45	6.41	139.86	2.94
2029	136.79	6.89	143.68	3.02
2030	140.02	7.33	147.35	3.09

Table 63. Annually Reduced Methane Emission Resulting from Measure Implementation

Year	CO_2 eq., Gg								
	Without Implementation of Measure			With Implementation of Measure			Reduction, %		
	Population	Visitor	Total	Population	Visitor	Total	Population	Visitor	Total
2012	1.30	0.02	1.32	1.30	0.02	1.32	0.00	0.00	0.00
2013	1.34	0.02	1.36	1.34	0.02	1.36	0.00	0.00	0.00
2014	1.43	0.02	1.45	1.43	0.02	1.45	0.00	0.00	0.00
2015	1.51	0.03	1.54	1.51	0.03	1.54	0.00	0.00	0.00
2016	1.66	0.03	1.69	1.66	0.03	1.69	0.00	0.00	0.00
2017	1.79	0.04	1.83	1.79	0.04	1.83	0.00	0.00	0.00
2018	1.92	0.05	1.96	1.92	0.05	1.96	0.14	0.44	0.15
2019	2.04	0.05	2.09	2.03	0.05	2.08	0.49	1.47	0.51
2020	2.16	0.06	2.22	2.13	0.06	2.19	1.02	3.05	1.08
2021	2.27	0.07	2.34	2.23	0.07	2.30	1.71	6.51	1.86
2022	2.38	0.09	2.46	2.32	0.08	2.40	2.41	10.22	2.68
2023	2.49	0.10	2.59	2.41	0.09	2.49	3.14	14.12	3.56
2024	2.59	0.12	2.71	2.49	0.09	2.59	3.89	18.13	4.50
2025	2.70	0.13	2.83	2.57	0.10	2.68	4.67	22.24	5.50
2026	2.81	0.16	2.96	2.65	0.11	2.77	5.46	26.42	6.56
2027	2.91	0.18	3.09	2.73	0.12	2.85	6.33	30.81	7.75
2028	3.02	0.21	3.23	2.80	0.13	2.94	7.26	35.36	9.07
2029	3.13	0.24	3.37	2.87	0.14	3.02	8.24	40.05	10.52
2030	3.24	0.28	3.52	2.94	0.15	3.09	9.28	44.84	12.10

The outcomes (Table 62 and Table 63) show that in case of project implementation to 2020 Methane emission from City Mtskheta Waste Sector will be reduced by 1.08%, and to 2030 – by 12.10%.

7.5 Wastewaters

According to the assessment document for Project "Rehabilitation of Sewerage System in City Mtskheta", regarding its impact on environment, yet back in 2011 it was planned to construct the central sewerage system collectors (collector "a" and collector "b" with total length 1 838m) in City Mtskheta and the wastewater treatment facility for 12 000 consumers at the adjacent territory of the confluence of Rivers Aragvi and Mtkvari[32]. Unfortunately, for the moment, the mentioned project has not been implemented yet and until now the settlements do not have any waste water collecting-treating facilities that causes pollution of water resources[33].

At present, providing water supply to City Mtskheta is carried out by Ltd. "Mtskheta Water", which presumably will serve sewerage systems and exploitation of water treatment facility. Unfortunately, as of now it is not known yet what is the term of implementation of the suspended above-mentioned project and what amendments will be made to it; hence, an assumption was made that the complete rehabilitation of the sewerage system and putting into operation the wastewater treatment facility meeting the modern requirements, which will serve the whole population of the city, will be carried out by 2018.

7.6 Methodology

Methane emissions depend on the content of degradable organic component (DOC) in wastewater. The amount of the DOC in wastewater is characterized with biochemical Oxygen demand (BOD) or chemical Oxygen demand (COD). The BOD is an aerobic parameter as its concentration shows only the amount of aerobically bio-degradable Carbon. The COD is for measuring the whole substance which may be oxidized with different oxidizers. The ratio between the BOD and the COD is about 0.5. The COD is anaerobic and aerobic oxidization index, and hence, it will be suitable to define DOC in anaerobic conditions.

Generation of Methane from waste waters also depends on the type of water treatment facility and the air temperature. Methane is basically generated by systems providing anaerobic conditional, while, the systems with aerobic conditions either don't generate or generate very small amount of Methane. With temperature growth, rate of generation of Methane is also increased. For generation of Methane it is necessary the temperature to be higher than 15^{0}C.

Methane emission from wastewaters depends on the DOC concentration in waste water, the volume of wastewater and the fields of industry, which are connected with the water treatment system, as well as, the type of industrial wastewater release/treatment.

To calculate the total emissions from household and commercial wastewater, the selected emission factor is multiplied by the fraction of appropriate waste water degradable organic component and is summed up.

For calculation of Methane emissions from waste water treatment process, the following equation is used:

$$WM = \Sigma_i (TOW_i \cdot EF_i - MR_i)$$

[32] http://www.greenalt.org/webmill/data/file/GA_Commetns_Mtskheta_20_06_2011.pdf

[33] http://nala.ge/uploads/mcxeta.pdf

Where:

WM - total/aggregated emission of Methane from wastewater, kg CH4;

TOWi - i type wastewater total DOC fraction, kg BOD/y;

EFi - i type wastewater emission factor, kg CH4/kg BOD;

MRi - i type wastewater total amount of Methane caught, or caught and further flared, kg CH4.

The full amount of fraction of DOC in household and commercial wastewater TOWdom kg BOD/year – is calculated with equation:

$$TOWdom = P \bullet Ddom \bullet (1 - DSdom)$$

Where:

P - Number of population, thousand;

Ddom - Household and commercial DOC, kgBOD/1000 residents per year;

Dsdom – fraction of household and commercial DOC separated in the form of sludge.

To calculate emissions from treatment of wastewater and sludge for the countries, which were not included into the Convention attachment, the standard method could be used, that considers only the population of cities and the residents living only in the cities, if it is known that the wastewaters produced in villages are decomposed in aerobic condition.

Methane emission factors depend on the content of those wastewaters, which are received from treatment with different methods, on the maximum volume of Methane generation from waste water, and the level of anaerobicity of the wastewater treatment process.

For wastewater treated with different methods the Methane correction factor (MCF) is determined separately and later the values are averaged. The average MCF is multiplied by maximum volume of Methane generation (Bo) characterized by the type of wastewater.

Emission factor for wastewaters is calculated using the following equation:

$$EFi = Boi \bullet \sum (WSix \bullet MCFx)$$

Where:

EFi - i type wastewater emission factor (kgCH4/kgDOC);

Boi - i type wastewater maximum volume of Methane generation (kgCH4/kgDOC);

WSix - i type wastewater factor, which is treated with x type system;

MCFx - wastewaters methane correction factor for each x system.

Activity Data

For the category of household and commercial wastewaters the activity data is total amount (TOW) of DOC:

TOW=P•BOD•0.001•I•365

Where,

TOW – total amount of organic components in wastewater, BOD kg/year;

P – Number of population;

BOD – BOD factor for the country per capita, g/person/day;

0.001 – Conversion factor from gram to kilogram;

I – Correction factor, which is used during mixing additional industrial wastewaters with household wastewaters (for collected I=1.25, and for not collected I=1).

During calculations the information from database of National Statistics Office of Georgia on the number of population was used, which is projected to grow by 2030 at 0,5% per year. As it was mentioned, at present the wastewater treatment facility is not operating and the wastewaters flow into the surface waters without any control. In case the wastewater treatment facility is built by 2018, the capacity of which is not known at this stage, the IPCC for City of Mtskheta was taken typical data for Europe and the region of former Soviet countries, 18 250 kg BOD/1000 person/year.

Emission Factors and Other Parameters

Methane emission factor depends on maximum volume of Methane generation from waste water and anaerobicity level of wastewater treatment process.

Emission factor for commercial and household wastewaters is calculated using the equation:

$$EF_j = Bo \bullet MCF_x$$

Where:

EFj - Emission factor (kgCH4/kg BOD);

x- Type of water treatment system;

Bo – Maximum volume of Methane generation (kg CH4/kg BOD); For calculations was used the value recommended by GPG: Bo=0.6kgCH4/kg BOD.

MCFx – Methane conversion factor, the standard value of which is given by IPCC 1996 methodology, within the frames from 0 (total aerobic conditions) to 1 (total anaerobic conditions). The MCF determines the fraction of Methane generation potential (Bo) which is decomposed in anaerobic conditions. According to the treatment methods of waste water treatment systems for City of Mtskheta from 2018 the value MCF=1 was taken.

7.7 Base Year Inventory and GHG Emissions Baseline Scenario (2012-2030)

In case of construction of water treatment facility starting functioning in 2018, the inventory of Methane emission from household and commercial wastewaters will give about 2.36Gg Methane emission per year.

For the baseline scenario, an assumption was made that in case of construction of water treatment facility, if the biogas generated from it is not rendered harmless, in the coming years (2018-2030) the amount of the emitted Methane in atmospheric air will have the growth tendency only at the expense of population's[34] growth (Table 64).

Table 64. Baseline Scenario 2018-2030 of Methane Emission from Mtskheta Water Treatment Facility

Year	CH_4				CO_2eq, Gg
	Gg/year	Kg/year	M^3/year	m^3/daily	
2018	0.1089	108 930.60	153 423.38	420.34	2.29
2019	0.1095	109 467.15	154 179.08	422.41	2.30
2020	0.1100	110 014.65	154 950.21	424.52	2.31
2021	0.1106	110 573.10	155 736.76	426.68	2.32
2022	0.1111	111 120.60	156 507.89	428.79	2.33
2023	0.1117	111 679.05	157 294.44	430.94	2.35
2024	0.1122	112 237.50	158 080.99	433.10	2.36
2025	0.1128	112 795.95	158 867.54	435.25	2.37
2026	0.1134	113 365.35	159 669.51	437.45	2.38
2027	0.1139	113 923.80	160 456.06	439.61	2.39
2028	0.1145	114 493.20	161 258.03	441.80	2.40
2029	0.1151	115 073.55	162 075.42	444.04	2.42
2030	0.1156	115 642.95	162 877.39	446.24	2.43

Mentioned calculations are performed for the case if the whole population of City Mtskheta will be connected with the sewerage system from 2018, and accordingly, Methane emission in atmosphere will be increased at about 6% by 2030, if the generated Methane is not used, or flared/ rendered harmless on the spot.

[34] In this case neither tourists nor the population of the adjoining territories is considered

7.8 Action Plan for Emissions Reduction from Wastewaters Subsector of Mtskheta

Within the frames of the SEAP it is planned to implement one measure at the water treating facility – arranging system of Methane collection and flaring on the spot (upon putting into operation the water treatment facility - 2018) which will result in emitting into the atmosphere Carbon Dioxide with significantly less warming effect, instead of generated Methane. The amount of emission reduced with implementation of the measure was calculated for the above-described case, when the number of population connected to the treatment facility makes 100% of the City Mtskheta population and its growth per year is 0.5%. An assumption was made that the Methane collection and flaring on the spot will start upon putting into exploitation the water treatment facility (Table 65).

Table 65. Amount of the Saved CO_2 in Case of Project Implementation

Year	Gg/year			
	CH_4	CO_2 eq	CO_2 produced from flaring of 80% of CH4	Saved CO_2
2018	0.1089	2.29	0.1471	2.14
2019	0.1095	2.30	0.1478	2.15
2020	0.1100	2.31	0.1485	2.16
2021	0.1106	2.32	0.1493	2.17
2022	0.1111	2.33	0.1500	2.18
2023	0.1117	2.35	0.1508	2.19
2024	0.1122	2.36	0.1515	2.21
2025	0.1128	2.37	0.1523	2.22
2026	0.1134	2.38	0.1530	2.23
2027	0.1139	2.39	0.1538	2.24
2028	0.1145	2.40	0.1546	2.25
2029	0.1151	2.42	0.1553	2.26
2030	0.1156	2.43	0.1561	2.27
2018-2030 Total	1.4593	30.65	1.9701	28.68

According to the Action plan, by 2030 CO_2 emission will be reduced by 2.27Gg. In these calculations two assumptions were made: one is that technically it is possible to collect only 80% of Methane and as a result of flaring of 1t Methane 2.75 t CO_2 is emitted into the atmosphere.

In case of project implementation, in total in 13 years 28.68Gg Carbon Dioxide will be saved from emission in the atmosphere (Table 65).

Table 66. Action Plan for Waste Sector

Activity	Planned Measures	Responsible Body	Implementation period (Start and End Dates)	Cost of Each Measure (GEL)	Expected CO_2 Reduction from Each Measure (t) by 2020	Expected CO_2 Reduction from Each Measure (t) by 2030
1	2	3	4	5	6	7
W	Solid Household Waste and Wastewaters				2 186	2 702
W1	Separation of Paper, Glass, Metal, and Plastics Fractions from Solid Household Waste for further Utilization	NELP "Amenities Services" of Mtskheta Municipality	2017		24	430
W2	Flaring of Methane from Wastewaters	NELP "Amenities Services" of Mtskheta Municipality	2018		2 162	2 272

8 Awareness Raising and Staff Training Strategies

In the Sustainable Energy development process the involvement of both the government and the public plays equally important role. Raising public awareness to introduce renewable energies, increasing energy efficiency and energy saving requires a complex and multilateral approach and the relevant communications strategy represents one of the most important components of the SEAP.

Despite the fact that the self-governing reform has started in Georgia in early 90s and for strengthening the self-governing units (among them in terms of legislation) periodically were made important steps, and coming out of the complexity of the process, as well as, certain political (unstable condition, governmental changes, etc.) or socio-cultural difficulties (mentality, tradition of central control, etc.), the potential of self-governing units in terms of effective management, planning, and obtaining financial independence still remains weak. In this respect, Mtskheta Municipality does not represent an exception; to be more precise, real decentralization processes are at the very earliest stage. Consequently, the main problem of municipalities and among them of Mtskheta Municipality is the lack of independent management experience, and, accordingly, the lack of experienced personnel, while, developing and implementation of the SEAP requires independent planning and searching additional funds and effective implementation of the planned measures. The preparation process of sustainable energy development strategy for Mtskheta Municipality within the frames of the CoM clearly revealed those basic barriers, which may create significant obstacles on the way of implementing of the strategy. Therefore, it is urgent to conduct proper evaluation of all identified barriers and set the ways of their overcoming. This assessment revealed that in the process of strategy implementation mainly three types of barriers will be dealt with, which are: general barriers existing in the country linked to bad past practices (especially in the sphere of public awareness), with the existing economic and social problems and the lack of knowledge related with technologies; barriers specific to Mtskheta Municipality and those ones related with concrete project proposals and technology.

Barriers to Sustainable Energy Development Process in Georgia

1. **Wasteful Approach to Energy Sector**, which is kept in public from the practices in Soviet period when energy was almost free of charge and consumption was unlimited;

2. Generally, **insufficient awareness of sustainable development process by local authorities and population**. Mainly, the small part of public directly engaged in these activities is aware of the concept of sustainable development;

3. **Absence of common vision** of the relatively long-term prospects of the Energy Sector development (different target groups still have sharply contrasting positions which often are not based on real calculations);

4. **There is no single, well-considered and formulated vision of the role of energy efficiency and renewable energy resources** in short-run and long-run perspectives of Georgia's Energy Sector development, while in recent years at average the 10% growth rate is recorded in energy demand annually. Accordingly, the potential of these recourses (except hydro) and the directions for development of this potential are not defined; there is no relevant legislation base and the set objectives similar to gasification or hydro-energy of the country.

5. **The technologies market is inferior and contains high risks.** Each failure of a new technology and the demonstration project is seriously damaging the follow-up prospects of the development in this direction. The long-run planning of Energy Sector is not conducted considering the availability of technologies;

6. **Activities** in the field of energy efficiency and renewable energies (except hydro) conducted by separate non-governmental organizations **are mainly uncoordinated and non-purposeful**. However, it should be stressed that the raise of energy efficiency, despite its chaotic character, is going on in the country that is partly facilitated by the market of contemporary technologies (mainly of domestic profile) and intrusion in Georgia of energy standards existing at the international level. Besides, the country has already started to work on developing National Energy Efficiency Action Plan that on its side will contribute to the growth of energy efficiency coordination at the municipality level.

While identifying these barriers it has been considered that the managerial team of Mtskheta Municipality has a vision of sustainable energy development prospects, demonstrates great interest to the adoption of modern, clean, energy efficient and renewable technologies and has relevant knowledge to certain extent but it lacks sufficient experience in managing present-day technologies and sustainable development planning, as well as, working with investors. Very often, in general, the support by the Municipalities is not fully reasoned out and lacks eyesight of what could be done at local level and how this or that measure could be realized effectively.

Barriers to Mtskheta Municipality Sustainable Energy Development:

Mtskheta Municipality faces the same main barriers in energy resource consumption planning process as all other regions and Municipalities in Georgia. **This is their complete dependence on the centralized energy supply and full reliance on the private sector concerning other energy carriers.** This dependence on centralized processes partly deals with the gas supply sector where municipalities mainly rely on the processes determined by plans worked out under the central government guidance. As for the gasoline, diesel, and other kinds of fuel, this is the prerogative of private importers. Accordingly, at this stage Municipalities have no vision on their roles in the energy planning process, as well as, on the risks related with centralized supply and do not plan measures to lessen these risks and hazards;

Mtskheta Municipality has no complete statistics on the energy consumption that would serve as a basis for planning growing energy demand. There is no vision and strategy to foresee energy supply of the Municipality in case of failure of one of the present rings in the energy supply system. Accordingly, the Municipality managerial team has no sufficiently thought-out energy efficiency urgency and its role in the process of sustainable socio-economic development. There is no sufficient vision of what problems the Municipality could face in case of rapid growth of economy and number of population, as well as, intensification of traffic network;

The Municipality **has no relevant experience, knowledge and sufficient technical personnel** to plan energy sustainable development process, as well as, manage and implement SEAP for Mtskheta Municipality. In particular, in the short-run strategy for energy sustainable development process in

Mtskheta Municipality the priority sector is **Waste Management. However, to secure the painless solving of the problems existing in the mentioned sector it will be needed to conduct a serious work with the public for raising their awareness;**

Very important barrier is as well **absence of free additional funds** to develop this direction (provision of energy sustainable consumption);

The local energy resource consumption sphere (except hydro) is unmanaged and chaotic at the level of both the Municipalities and the entire country;

In the case of Mtskheta Municipality all those barriers are acute, which are typical and general for the whole country.

Apart from the discussed above barriers related with each concrete technology, there exists some specific barriers which are to be envisaged in the process of SEAP implementation for assessment of the selected and applied technologies.

Barriers related to Technologies:

Lack of knowledge about the modern energy-efficient and renewable technologies which are available at the international market. Only a small number of technologies are assessed and studied for their adaptation in Georgia that significantly increases the risks related with introducing them in the country. Neither private banks nor the private sector is willing to take upon the risks. Consequently, the import of technologies, their dissemination and adaptation is almost totally in the hands of non-governmental sector or those big investors who are interested in developing market for their own technologies. Accordingly, the high quality technologies which are imported at the limited scale are accompanied with large part of worthless technologies. This is mostly promoted by the cost of the technology and, unfortunately, even for short-run prospective;

Lack of knowledge about the local environment in which certain technology should operate (for example, energy-efficient bulbs become absolutely ineffective and economically unprofitable within old and improper functioning electricity network). Studies of these aspects bring additional cost to technologies and raises their prime cost;

Lack of knowledge on environmental and social counter-indications of the technologies. The study of technical risks associated with technologies requires profound understanding of technology by the accepting party to insure relevant assessment of risks and their minimization; in case of Georgia, experience of assessment of these types of risks actually does not exist;

Lack of sufficiently trained local personnel which could be able to select correctly certain technology with respect to local conditions and provide its proper operation. This problem is especially acute at the level of the Municipalities and self-governing cities;

Most renewable technologies are not sufficiently flexible and easily adaptable to different environments. Majority of them lack market shape and their adaptation to local conditions requires additional funding and knowledge.

Analysis of stakeholders in the frames of Mtskheta Municipality SEAP has identified target groups for awareness raising and retraining, with which active collaboration should be conducted to overcome the majority of the listed above barriers. However, it should be stressed that there are barriers common with the country, the over-passing of which will be extremely difficult without the serious intervention from the government.

The target groups to be engaged in the awareness raising process to which this strategy is addressed are as follows: Mtskheta Municipality staff and City Assembly members; Companies engaged in the spheres of Waste Management and Tourism; Mtskheta Municipality population.

In case of Mtskheta Municipality, among those sectors which need awareness raising programs is Waste Sector; thus, for implementation of Action Plan it is necessary to plan and execute such measures, which require intense informing and awareness raising among Mtskheta Municipality population and the above-mentioned target groups on the measures to be implemented in Waste Sector and prospect for the sustainable development of this sector.

At the territory of City of Mtskheta there is no official or unorganized landfill. The Municipality delivers the collected waste to the landfill located at Kaspi Municipality territory. In order to improve collection and delivering waste from the city in 2016 it is planned to purchase 100 waste collecting containers and 2 waste delivering vehicles (with $7m^3$ and $14m^3$ capacities).

Besides, the sustainable development of the city should also be viewed in the context of tourism, as tourism is the leading and perspective economic field for city Mtskheta. The number of tourists arriving in Mtskheta is constantly growing[35] starting from 2012 including 2015. The number of tourists is interesting and noteworthy due to the fact that potentially tourists make the majority of consumers of local service (hotels, tours, souvenirs, local cuisine, etc.), that on its side plays certain role in producing a big amount of waste.

Generally, it is essential the population to be aware of the SEAP and to make for them understandable its objectives and the positive social and economic sequels, which could be obtained in case of its successful implementation. To achieve maximum support from the side of population it is necessary to carry out some behavioral changes among the population, as well as, to provide its involvement in the process of developing the plan. Global practice has demonstrated that the higher is population's involvement at the early stage of the process, the more effective is implementation process, and the higher is the public support.

At the initial stage of the SEAP development, meetings and consultations with the population of Mtskheta Municipality (among which, presumably, the most part of behavioral changes will be needed) will be necessary in order to explain the expedience and benefits of the project implementation. During the consultations new project ideas could arise, or the necessity of making amendments to the planned projects may be revealed.

In the process of implementation the Mtskheta Municipality SEAP, with the aim of the awareness raising and local staff training, a short-run strategy has been developed set out until 2020. If Mtskheta Municipality joins the new agreement of Covenant of Mayors (until 2030), according to which will be revised the current Action Plan, the awareness raising long-run strategy (2020-2030) will be developed in the process of revising the strategy.

[35] Department of Education, Culture, Tourism, Sports and Youth Affairs of Mtskheta

Short-run Strategy 2015-2020

Informing local authorities regularly on the energy consumption trends, the advantages and prospects of efficient consumption of energy resources, and providing sustainable development, as well as, on social and economic benefits of this initiative. Regular training/retraining of local personnel for developing future plans and improving the skills for mobilization of additional financial sources;

Training/retraining of the Municipality personnel and external human resources to ensure successful implementation and monitoring of the SEAP;

Provision of Mtskheta Municipality with the technical staff, which will guarantee the development of energy efficient/low emissions projects in Waste Management and other sectors;

Preparation of information/education/illustrative materials about successful experiences and modern technologies that are recommended for the green development of the Municipalities; Demonstration for the population the advantages of implementation of energy efficient measures and introduction of technologies in different sectors (Transport, Waste Management, Tourism);

Ensuring the involvement of private sector in the implementation of the SEAP, providing them with information on energy efficient and economically beneficial technologies, as well as, offering programs on cooperation between public and private sectors.

Awareness Raising and Staff Training Short-Run (2015-2020) Strategy for Mtskheta Municipality

Main Strategic Objectives	Main Target Groups	Measures to be Implemented	Potential Leading Organization(s)	Outcome	Potential Donors
Short-run Strategic Objectives (2015-2020) • The main objective of short-run strategy is facilitation of the systematic awareness of the Municipality Administration / Managerial Team on the prospects of sustainable energy development and its social and economic benefits; • Highest possible notification and awareness raising of main target audience (population, Waste Management and Tourism Sectors) on implementing energy efficient measures; • Assisting the population and other stakeholders in getting advantages from this initiative and training appropriate personnel for implementing the Action Plan and provision of its monitoring.	• Mtskheta Municipality and Municipality Assembly • Mtskheta Municipality population • Companies engaged in the spheres of Waste Management and Tourism		• Mtskheta Municipality Administration • Coordinators of CoM in Georgia (Ministry of Energy and Ministry of Environment and Natural Resources Protection) • Different local and international programs going on in the frames of CoM and EC-LEDS	• Implementation of Mtskheta Municipality SEAP is advancing successfully • Mtskheta Municipality continues the same activity after 2020 and enhances it • Mtskheta Municipality population is informed about the initiatives undertaken by the authorities in the frames of this process	• Mtskheta Municipality Administration • Coordinators of CoM in Georgia (Ministry of Energy and Ministry of Environment and Natural Resources Protection) • Different local and international programs going on in the frames of CoM and EC-LEDS • International donors contributing to Climate Change mitigation and renewable energy, energy efficiency and sustainable development process.

1. Staff Training					
• Training of technical personnel for Mtskheta Municipality which will be able to assist the population and the companies engaged in the Waste Management Sector in preparing and implementation of energy efficient/low emissions project proposals	• Technical Experts Group under the Mtskheta Municipality Administration • Special Service established by the City Hall (this may be Energy Efficiency Agency, or Sustainable Development Agency) which will provide service to the City Hall, as well as to the population and the private sector in preparing and implementation of specific project proposals in different sectors	• Under the support of Mtskheta Municipality Administration, the "Energy Agency/Energy Manager" should be set up, serving both the Administration and collaborating with the population, and generally, with private sector in preparing energy efficient projects and offering modern energy efficient technologies • Elaboration of training program for Technical Group. The program should include at least the analysis of modern technologies and the barriers to their introduction, as well as the study of advantages of different energy-efficient measures. • Development of manuals for the Technical Group • Involvement of Technical Group in exchange programs and various information networks for getting international experience.	• Mtskheta Municipality Administration • Representatives of private sector from different countries, engaged in this sphere.	• The program and manual are developed for training personnel of the City Hall's Technical Group • The staff is trained and selected in accordance with competition rules. • Technical Group is actively involved in exchange programs and international networks to obtain newest information on present-day technologies and approaches in energy sector • Technical Group is actively collaborating with population, private sector and Municipality in the process of implementation of energy efficient measures	• Mtskheta Municipality Administration • EC-LEDS Project • USAID • GIZ • EU • Different projects and programs which work for enhancing of local potential

• Training of the personnel for Mtskheta Municipality who will have appropriate skills to work out future development plans, to mobilize additional financial sources and will be able to prepare recommendations for successful implementation of the CoM process	• Mtskheta Municipality Administration SEAP Group • Special Service established by the Municipality Administration (this may be Energy Efficiency Agency, or Energy Manager, or Sustainable Development Agency), which will provide service to both the Administration, and the population and private sector with recommendations	• Setting up within Mtskheta Municipality Administration or outside it Special Group/Service, which during the implementation of SEAP and its monitoring will serve the Administration, the population and the private sector with offering modern technologies • Elaboration of training program for the mentioned group. The program should cover at least sustainable energy and climate change mitigation measures, the EU directives, requirements of CoM, and the analysis of modern technologies considering the analysis of barriers to their adoption • Developing manuals for the mentioned group • Involvement of the Group in exchange programs and various information networks for getting international experience. • The potential candidates appropriate for this group should be involved, as far as	• Mtskheta Municipality Administration • Ministry of Energy • Ministry of Environment and Natural Resources Protection • Representative of CoM process in Georgia	• The program and manual are developed for training the personnel of the Municipality Administration SEAP Group • Their responsibilities and working program is outlined distinctly, which considers assistance to the Administration and collaboration with the population and private sector • SEAP group is actively involved in exchange programs and international networks for getting newest information on modern technologies and approaches in Energy Sector • Technical Group is ready to train the needed staff for private sector	• Mtskheta Municipality Administration • EC-LEDS Project • USAID • GIZ • EU

		possible, from the very beginning in the process of SEAP preparation			
2. Public Awareness Raising and Dissemination of Information					
• Widest Dissemination of Information and Raising Public Awareness. • Widest possible dissemination of information and awareness raising among the general public on the social and economic advantages which will be achieved in the process of SEAP implementation; • The main direction of the Municipality will be dissemination of information among population, Waste Management and Tourism Sectors • Providing the population with consultations about the energy efficient measures to be carried out in the priority sectors and	• Mtskheta population • Companies engaged in Waste Management sphere • Non-governmental sector • Other public associations	• For target groups development of information materials on measures and technologies, which will improve and provide healthy environment for the Municipality population • Preparation of information materials for the population about Mtskheta Municipality (e.g. on its potential in terms of green development and how can the population contribute to these processes). • Preparation of information material for the population on the energy efficient/low emissions development measures undertaken by CoM signatory cities and municipalities and their outcomes • Systematic meetings with population	• Mtskheta Municipality Administration • Non-governmental sector	• The TV trailers and programs are prepared for local TV channel • Updating of information for the population of Mtskheta Municipality is performed at the Municipality web-site (http://mtskheta.org.ge) and at facebook page (https://www.facebook.com/mtskhetismunicipaliteti/?fref=ts) • Information booklets are developed on the preferences of energy efficiency measures and their application. • Several pilot	• Mtskheta Municipality Administration • USAID • GIZ • EU

delivery newest information on technologies available at the market and especially on their introduction, with special accent on the worldwide best practice in this field.		• Involving the population in the process of pilot projects development and implementation		projects are implemented, providing maximal involvement of population.	
3. Systematically Informing the Mtskheta Municipality and the Assembly Representatives					
• Provision of informing local authorities on the advantages and prospects of low emissions/green development by the Municipality, on the social and economic benefits of this initiative	• Mtskheta Municipality Administration • Mtskheta Municipality Assembly	• Holding awareness raising workshops for Administration and City Assembly representatives on the advantages and prospects of the measures planned to be implemented by the Municipality in the spheres of Waste Management • Encouraging participation of Administration and City Assembly staffs at international meetings and conferences on the CoM process. • Inclusion of mass-media representatives in the high level meetings on the CoM issues and maximal public awareness raising through this way on the current	• Regional Energy Efficiency Center (in case such center is established) • Ministry of Energy of Georgia • Ministry of Environment and Natural Resources Protection of Georgia	• Illustrative materials are prepared for holding information meetings; • Awareness raising meetings are being held (at least twice a year); • Experts from the EU and other donor countries are invited to carry out workshops on modern technologies and approaches; • The approved resolutions and discussed projects and measures are publicized by mass-	• EC-LEDS • USAID • EU-COM • GIZ • Partnership for mitigation • GHG emissions reduction projects • Georgia's National Communications on Climate Change

		processes. • Providing the decision making process in the frames of CoM via consultations with stakeholders.		media. • Representatives of City Hall and City Assembly are fully involved in processes going on both in the country and at the international level; • Constantly updated information on current processes and projects is available at the City Hall website/Facebook page.	
4. Involvement of Private Sector in Achieving the SEAP Objectives					
• Strengthening of private sector involvement in the SEAP implementation by providing information on energy-saving and beneficial technologies, offering programs on cooperation between public and private sectors.	• Private Sector (at this stage Waste Management and Tourism Sectors) • Initiative groups of private sector	• Taking an interest of private sector using different stimulating mechanisms in the application of innovative technologies • Providing consulting services to private sector aimed at decreasing the risks; • Setting up of different funds, aiming the deployment of new technologies for the	• Mtskheta Municipality Administration • Energy Efficiency Center • Private Sector • Non-governmental Sector	• Various measures are being held annually • Motivating mechanisms for private sector are elaborated to provide its involvement in processes of new technologies development and	• Mtskheta Municipality Administration • Private Sector • EU COM • GEF • UNFCCC Programs

		reduction of risks, related with adapting of new technologies; • Promoting the creation of private sector initiative groups, facilitating maximal involvement of this sector in the CoM processes.		introduction; • The Energy Efficiency Agency/Energy Manager is set up, providing consultations on the deployment of new technologies; • Risk-insurance financial schemes related with technologies are created for the private sector; • Initiative groups are organized in different sectors, being the main connecting ring between the state and private sectors; • Representatives of private sector are incorporated in international processes, associations and professional networks.	

5. Identification of Barriers by Consulting with Stakeholders					
• Identification of barriers via consultations with stakeholders, which may arise in the process of introducing restrictive measures and different types of standards which presumably will be the main direction of the long-term strategy	• Mtskheta Municipality Administration • Mtskheta Municipality Assembly • Mtskheta Municipality population • Active Private Sector of Mtskheta Municipality (Waste Management and Tourism Sectors) • Non-governmental Sector	• Identification of barriers in the process of consultations with the population on the developed standards and restrictive measures for the long-term SEAP sectors; • Working out of measures to overcome the determined barriers by consulting with different target groups	• Mtskheta Municipality Administration • Mtskheta Municipality Assembly	• Groups are identified (private sector initiative group, non-governmental sector, mass-media) to carry out consultations; • For each sector, discussed in the SEAP, barriers are identified; • In cooperation with target groups the measures to overcome the barriers are revealed.	• Mtskheta Municipality Assembly

The Implementation Structure

- This strategy, as a constituent part of the Development Action Plan, is approved and its implementation is monitored by the Mtskheta Municipality Assembly;
- The responsible body on revising and implementation of the Strategy is the Mtskheta Municipality Administration;
- The responsible body for training of local staff, necessary to execute the Strategy and monitor its implementation will be the "Energy Efficiency Agency"/"Energy Manager" (it may be "Sustainable Energy Development Agency) under the City Hall, setting up of which is one of the priorities of Mtskheta Municipality Administration and is planned by the Administration. For creating potential of this agency the local or international programs within the frames of CoM will be used.
- Developing of awareness raising and information dissemination materials at the initial stage mainly should be conducted using the external resources (non-governmental sector).

9 Plan for the Monitoring, Verification and Reporting on the Implementation of SEAP and GHG Emissions Reduction in Mtskheta

To plan and carry out monitoring measures on the implementation of Mtskheta SEAP and the reduction of GHG emissions, the way local government reforms are carried out is of significant importance. These reforms must ensure high quality of municipalities' independence. Obligatory factor for that is strengthening local potential in all directions including monitoring course of processes. Interior structures of municipalities have lack of adequate staff (especially high quality managers who own sectors and have information about the trends of their development) at this stage. During preparation of this monitoring plan municipality has a coordinator of CoM process (one person) who (together with other affairs) has created temporary working group that takes part in preparing SEAP. Strengthening existing potential and bringing additional resources will be needed for implementing SEAP and ensuring stability of monitoring. In this process it is very important how effective will be a mobilization, increasing and distribution of local financial and human resources. Lack (often even missing) of needed resources and adequate technical skills and knowledge is one of the biggest barriers for municipalities during preparing and implementing SEAPs.

That is why, in this transitional phase, the monitoring plan can include several options, however a distribution of functions and clear separation of rights and responsibilities between internal structural units of municipalities and external resources will be most effective. This option means combine use of internal and external resources for monitoring.

Creating the action plan showed that one of the most important problem of Mtskheta and other cities in Georgia is obtaining data on energy consumption from the necessary sectors for the base year emissions inventory. In many cases, no data accounting system existed since they were not previously used to evaluate economic parameters. It must be said that this information was not needed in the past because municipalities were not self-governing units. Sometimes the database needs additional processing, which can only be done by the owners of the source data because there is always additional commercial information that could be confidential. Generally, the collection of necessary data requires significant time and human resources, but municipalities do not have well organized statistical/analytical tools or analytical departments. With the exception of some larger municipalities, there are no municipal-level statistics offices in Georgia, and this impedes both, SEAP implementation and monitoring. To reduce the risks from a lack of data, the

"Monitoring" section of the Mtskheta SEAP offers a performance methodology that seeks to compensate for these lacunae. One measure is to create a data register for monitoring baseline scenarios that is updated regularly with systematic information from the Mtskheta SEAP monitoring group. Thus monitoring, verification and reporting will take a minimum of time, as they can use regular updates from available data.

For internal monitoring and analysis, the responsible department/divisions of Mtskheta City Hall should have software that is easy to use for non-specialists that calculates baseline scenario emissions and quantities of reduced emissions for different measures or combined data from the BAU scenario. Local staff will undergo software training to ensure effective use of the program.

Simple software Muni EIPMP for municipalities has been prepared by Sustainable Development Centre – Remissia in the network with Development of Potential for Low Emission Strategy under USAID. This software allows municipalities to calculate BAU scenario of energy consumption and reduction potential or reduced GHG emissions by themselves, in case of appropriate statistic data. Signatory municipalities of the CoM and self-governing cities including representatives of Mtskheta Municipality are systematically trained for using Muni EIPMP.

During preparation of monitoring periodic reports for implementation of action plan, that is obligatory due to terms of CoM, is possible to include invited expert(s) in monitoring process at least during preparation of the first obligatory report.

Main activities included in the Monitoring and Reporting process of Mtskheta are:

1. Regular updating of the Baseline Scenario (BAU);
2. Assessment of emissions reduced after taken measures and implemented projects;
3. Development of final report;
4. Determine how to simplify the monitoring system in future.

Under the current action plan the parties responsible for these activities are:

1. The Mtskheta Municipality: responsible for obtaining statistical information about main parameters (GDP, population, per capita income, share of economic activities/economic sectors in GDP, etc.), and describing city development processes. To calculate the baseline scenario, external technical assistance could be approved by the municipality for carry out this work. The calculation of the baseline scenario and a renewal methodology plan as well as the simplified computer program (MUNI – EIPMP) will be sent to the City Hall under the LEDS by the Georgian Government and coordinated with the CoM. Emissions factors will also be aligned with the responsible authority of the UN Framework Convention on Climate Change in Georgia.
2. Implementing Unit/Project owners who will collect information needed to calculate reduced emissions. The Municipality will provide them with the data collection methodology and will ensure periodic verification. The Municipality is responsible for calculating and verifying final emissions, although the work can be done either by the Municipality, or by external expertise accredited by the CoM. Periodic verification of activity data provided by the project executor is the responsibility of the Municipality as well.
3. The City Hall is responsible for a final report that must be approved by the City Council, after which it will be submitted to the EU.

The Report includes elements of monitoring process, general parameters that have to be monitored during the SEAP implementation, quality assurance and quality control (QA/QC) procedures and emissions factors. Based on this, a specific year baseline scenario will be updated and reduced emissions calculated.

9.1 Responsible unit for the monitoring in Mtskheta Municipality

Responsibility of Mtskheta City Hall is development and implementation of the SEAP, its systematic updating according to new circumstances and development plans. At this stage, specially appointed coordinator is responsible for monitoring, analysis of its results and foreseeing of these results in renewing process of action plan, verification of monitoring data and preparing final report of monitoring that will be approved by Mtskheta Municipality Assembly before presenting it in EU together with "Ketilmotskobis Samsakhuri" of the City Hall. Coordinator and "Ketilmotskobis Samsakhuri" are also responsible for gathering the activity data, improvement of their quality and updating, identifying the new sources. Coordinator and "Ketilmotskobis Samsakhuri" can use in this process other Departments and LLC-es, subordinated to the Municipality, as well as certified external resources. Initially and later on the resources of nearest Regional Energy Efficiency Center could be employed as well. In case of setting up of Regional Energy Efficiency Centres, this part of monitoring should be correspondingly modified and significant portion of activities, listed here will be implemented by them.

There are five main sectors considered within the Sustainable Energy Action Plan of Mtskheta municipality: Transport sector, Buildings sector, Street lighting sector, Wastes and Increasing emission sinks by green area development. In order to evaluate each sector's baseline scenario, information on activity data is necessary. Each implemented project and measure must be monitored for its quantitative emissions reduction value and its total emissions savings compared with the baseline scenario. The amount of final emission reductions can then be analyzed. At this stage, Mtskheta municipality is considering two options:

- Responsible for collecting and delivering necessary statistical data for monitoring each sector will be appropriate departments of the city hall;
- Creating new structure that will be responsible even for securing statistics;
- Figure below demonstrates departments of City hall and LTDs that were taking part in creation of SEAP and presumably will be responsible for gathering data for monitoring.

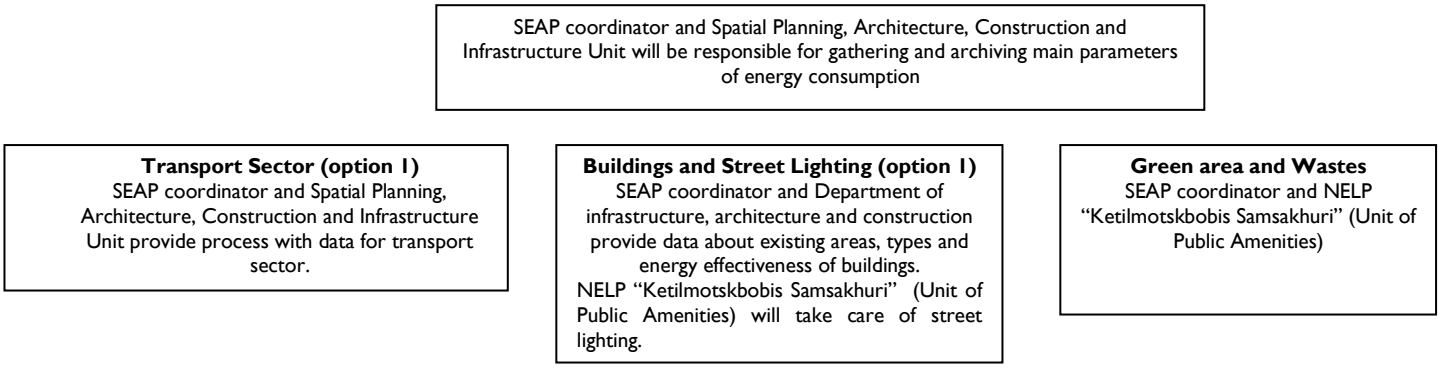

Fig. 15. Monitoring Process Management

Four types of data will be collected and evaluated to prepare monitoring reports for each sector:

- Annual emissions in CO_2equivalent;
- Measures and project implementation status and emissions savings for a given period;
- Driving parameters of the baseline scenario (for example, in the transport sector: population, GDP, income growth and passenger-kilometers according to transport types);
- Economic and social effects of the measures taken.

In addition to these types of data other parameters can be considered for the monitoring process, taken from primary and secondary data. Primary data is gathered from different sources by responsible group. Secondary data is based on primary data and then automatically calculated with muni_EIPMP software.

An approved special Technical Group and Energy Manager be responsible for annual reporting. These will be compiled every two years and submitted to an independent third party for verification. It is implied that the third party will be provided by EU Covenant of Mayors Office. The monitoring report structure is already worked out by the EU Research Centre, however it is expected that for the perfection of monitoring process new approaches and methodologies will be gradually introduced. In this case, where it will be relevant, the results obtained under the old methodology must be recounted with the new one to provide the conformity of results acquired in different years to the BAU data.

9.2 Monitoring of main driving parameters featuring GHG baseline inventory (BEI), BAU scenario and GHG baseline inventory monitoring (MEI)

The purpose of discussed below parameters is to conduct the MEI and update the BAU scenario in view of important social and economic changes going on in the city. Information presented in Tables below refers to 2014, taken as a base year for the GHG inventory in the Mtskheta SEAP. On the basis of these parameters and their 2014 values the Mtskheta municipality energy consumption development scenario (BAU) has been developed for 2020. In comments it is explained how to update these parameters for the compilation of SEAP Monitoring Report.

Data/Parameter #9.2.1	**Population in Mtsketa through monitoring year**
Data Unit:	Number of population
Description:	Primary data[53]; Annual monitoring.
Source of data use:	Annual statistics (www.Geostat.ge) and local statistics
Value applied:	9 800 (2014)
Any comments	On the basis of number of population in the monitoring year the increment should be calculated relevant to 2014 and the compliance with the reality of SEAP assumption on population growth must be assessed. This information will be used later in the comparative analysis of new and old BAU scenarios aimed at revealing the causes of deviation.

Data/Parameter #9.2.2	**Gross Domestic Product (GDP) in the monitoring year**
Data Unit:	Million GEL
Description:	Calculated data; Annual monitoring
Source of data use:	Statistical annual (www.Geostat.ge) and local statistics. This SEAP source was Mtsketa Municipality.
Value applied:	This value has not been used in SEAP, because it did not exist, but must be evaluated for future monitoring. GDP for Mtsketa Municipality is not calculated but rise in Mtsketa-Tianeti Region is 11% for 2011-2014 years.
Any comments	National Statistics Office publishes information only about annual GDP of the Region. In this case, using the Kakheti Region's GDP and its total population, the per capita GDP in this Region could be evaluated, multiplied further by the number of population in Mtsketa. Besides such assessment more precise methods could be used which also must be well described as well. The value of GDP in the monitoring year is used for recounting the BAU scenario, additional check-up of different quantities and their observation, data control and monitoring of emissions trends per unit of GDP, assessment of emissions intensity in the process of eonomy development.

Emission factors

Data/Parameter #9.2.3	**Grid emission factor** CO_2T/MWh
Data Unit:	**CO_2** T/MWh
Description:	Primary data. Calculated at the national level and provided to municipalities
Source of data use:	Calculated especially for SEAP, but there is also a value calculated for the Kyoto Protocol's Clean Development Mechanism projects (Ministry of Environment and Natural Resources Protection of Georgia)
Value applied:	0.104 t CO_2/MWh (Area of grid emission for 2014)
Any comments	The emissions factor is calculated using average method by dividing annual emissions from the power sector by annual electricity generation. This emission factor is calculated centrally in order to monitor low emissions and is delivered to municipalities for their SEAPs. During Mtskheta SEAP preparation the used grid emissions factor has been calculated by averaging, since Mtskheta does not produce electricity independently but receives it from the centralized energy system of Georgia.

Data/Parameter #9.2.4	**Natural Gas (NG) emission factors**
Data Unit:	t/TJ, or Kg/TJ
Description:	Primary data
Source of data use:	At this stage, the IPCC calculated typical value is being used (applied for Tier 1 calculations)
Value applied:	55.78 CO_2 T/TJ; 5 CH_4 Kg/TJ; 0.1 N_2O Kg/Tj.
Any comments	It is recommended to use the national calculated value that depends on the natural gas calorific value (NCV). This should be updated constantly during the monitoring process using information about gas caloricity consumption.

Data/Parameter #9.2.5	**Gasoline emission factors**
Data Unit:	t/TJ, Kg/TJ
Description:	Primary data
Source of data use:	At this stage, the IPCC calculated typical value is being used (applied for Tier 1 calculations)
Value applied:	68.6 tCO2/Tj; 20 Kg CH4/Tj; 0.6 Kg N2O /Tj.
Any comments	It is recommended to use the national calculated value that depends on the carbon content of gasoline, and should be updated constantly during the monitoring process according to information on imported gasoline caloricity.

Data/Parameter #9.2.6	**Diesel emission factors**
Data Unit:	t/TJ, Kg/TJ
Description:	Primary data
Source of data use:	At this stage, the IPCC calculated typical value is being used (applied for Tier 1 calculations)
Value applied:	73.3 tCO2/Tj; 5 Kg CH4/Tj; 0.6 Kg N2O /Tj.
Any comments	It is recommended to use the national calculated value that depends on the carbon content of diesel, and should be updated constantly during the monitoring process according to information on imported diesel caloricity.

Data/Parameter # 9.2.7	Net Calorific Value of Different Fuels (NCV) for, NG, Gasoline, Diesel
Data unit:	TJ/Unit of fuel
Description:	Primary data. These data should be collected at the national level from fuel importers.
Source of data used:	At this stage, typical values are used in the SEAP, provided by the IPCC
Value applied:	Gasoline 44.80 TJ/1000 t Natural Gas 33.59 TJ /mln.m^3 Liquid Gas 47.34 TJ/1000 t Diesel 43.33 TJ/ 1000 t Firewood 7.50 TJ/1000 m^3 Coal 14.65 TJ/1000 t
Any comments	These data should be collected in the future for each type of fuel used in the country. The information sources are mainly fuel importers and distributors. Systematic update is recommended taking into account fuel parameters. It would be better to apply these typical data if local statistics is not available.

9.3 Transport

Public Transport (minibuses)

Data/Parameter # 9.3.1.1	**Number of municipal public transport-minibuses**
Data unit:	Number of minibuses through the monitoring period (annual value)
Description:	Primary data.
Source of data used:	Mtskheta Municipality Transport Company
Value used in SEAP	**2014 - 0 buses** **2020 – 6 municipal buses for local residents and 8 electric buses are planned to be added**
Any comments	Responsible for this information is Mtskheta City Hall. Municipality must verify these data during monitoring process, comparing it with used fuel costs that must be requested from financial department.

Data/Parameter # 9.3.1.2	**Average distance traveled annually by one ibus according to fuel type (gasoline, diesel, NG)**
Data unit:	Km/yr
Description:	Primary data.
Source of data used:	Department of infrastructure, architecture and construction of Mtskheta City Hall and

	LTD "Ketilmotskobis Samsakhuri". Provided to SEAP by Mtskheta Municipality.
Value applied in SEAP:	**2014 –** 91 250 Km/yr **Planned for 2020:** • **One bus for local residents covers 29200 km annually;** • **One electric bus for tourists covers 2920 km annually**
Any comments	It is recommended that this data be gathered according to daily covered distance

Data/Parameter # 9.3.1.3	Total average distance traveled by all buses annually according to fuel type (gasoline, diesel, NG)
Data unit:	Km/yr
Description:	Secondary data, calculated by 9.3.1.3=9.3.1.2*9.3.1.1
Source of data used:	Calculated by monitoring and SEAP groups
Value applied:	**2014 – 0 km/yr** **2020 (planned)- 198 560 km/yr (electric buses)**
Any comments	Municipality must verify these data during monitoring process, comparing it with used fuel costs that must be requested from financial department.

Data/Parameter # 9.3.1.4	Average consumption of fuel by 1 bus per 100 km (electricity)
Data unit:	KWh/100 km
Description:	Primary data
Source of data used:	Provided by independent experts of department of transport of Mtskheta City Hall
Value applied:	**2014 -0** **2020 (planned) -100 KWh/100 km**
Any comments	This data must be checked with bus technical passport and must be explained in case of big difference.

Data/Parameter # 9.3.1.5	**Annual amount of used fuel by all city buses**
Data unit:	KWh/yr
Description:	Secondary data. Calculated
Source of data used:	2014 is calculated by SEAP group
Value applied:	**2014 – 0** **2020 – 198 560**

Any comments	This data is calculated so: **9.3.1.5.= 9.3.1.3*9.3.1.4 / 100** It can be calculated by parameter 9.3.1.3 and fuel cost on 100 Km if fuel types and buses are similar. This data must be checked by Construction and Architecture departments and monitoring group by using financial costs used on fuel.

Data/Parameter # 9.3.1.6	**Passenger turnover per year (quantity of passengers ferried by all buses per year)**
Data unit:	Passenger/yr
Description:	Secondary data. For Mtskheta it is calculated by Municipality Construction and Architecture Office according to daily data
Source of data used:	Provided to SEAP by Municipality Construction and Architecture Office of Mtskheta municipality.
Value applied:	**2014 – 0** • **City buses 1600 passengers per day** • **Touristic buses -3000 passengers per day**
Any comments	City bus company calculates by sold tickets that can be checked with data of financial department by economic development group.

Public transport (public microbuses, independent from the municipality)

Data/Parameter # 9.3.2.1	**Number of private microbuses (by fuel type)**
Data unit:	Number of cars through period of monitoring
Description:	Primary data
Source of data used:	Provided to SEAP by an independent expert of Mtskheta City Hall who interviewed local taxi drivers
Value applied:	**2014:** **On the territory of the municipality 8 (Diesel)** **Mtskheta - Tbilisi 6 (Diesel)**
Any comments	On the territory of municipality were 8 local and 6 interurban (Tbilisi – Mtskheta) microbuses in 2014. They cover 14*80=1120 km in total annually. Local microbuses (16) belong to LTD "Mtskhetis Akhali Avtosadguri" and Tbilisi-Mtskheta microbuses belong to LTD "Trans Didube".

Data/Parameter # 9.3.2.2	**Average annual distance traveled/run by one vehicle (by fuel type is recommended)**
Data unit:	km/yr
Description:	Primary data.
Source of data used:	Provided to SEAP by an independent expert of Mtskheta City Hall.
Value applied:	1 microbus (diesel)on the territory of Mtskheta covers 29 200 km annually (80

	km per day). 1 microbus (diesel) on the territory of Tbilisi-Mtskheta covers 29 200 km annually (80 km per day) only on the territory of Mtskheta
Any comments	LTD Mtskheta Auto Station is private and does not belong to the municipality. It is not regulated by municipality but is financially accountable by Economic Development and Property Ruling groups. Verifying their data is possible by municipal government. Tbilisi-Mtskheta microbuses belong to LTD "Trans Didube".

Data/Parameter # 9.3.2.3	**Average distance traveled by all microbuses per year (by fuel types)**
Data unit:	km/yr
Description:	Calculated by MUNI_EIPMP
Source of data used:	9.3.2.3=9.3.2.1.*9.3.2.2
Value applied:	**2014:** **Total distance covered - 408 800** **Local microbuses (diesel) - 233 600** **Mtsketa-Tbilisi microbuses (diesel) - 175 200**
Any comments	

Data/Parameter # 9.3.2.4	**Average fuel consumption by microbuses per 100 km (by fuel type)**
Data unit:	l/ 100 km (Gasoline, Diesel) m^3/ 100 km (NG)
Description:	Primary data.
Source of data used:	Provided to SEAP by an independent expert
Value applied:	**10 l/100 km (Diesel)**
Any comments	Logically, this data must be verified with microbus technical passport and must be explained in case of big difference. These microbuses are secondary, customized many times, move on a bad roads and that difference may be logical.

Data/Parameter # 9.3.2.5	**Fuel annual consumption by all microbuses according to fuel types (gasoline, diesel, NG)**
Data unit:	l/yr m^3/yr
Description:	Secondary data. Should be calculated by Monitoring Group
Source of data used:	Calculated with MUNI-EIPMP. 9.2.5=9.2.1.*9.2.2.*9.2.4/100 Number of fuel powered microbuses multiplied by fuel consumption per 100 km, multiplied by one microbus annual run and divided by 100.

Value applied:	**2014:** **Local microbuses (diesel) – 23 360 l = 245 MWh= 65 t $CO_{2\ eq.}$** **Mtsketa-Tbilisi microbuses (diesel)– 17 520 l = 184 MWh = 49 t $CO_{2\ eq.}$**
Any comments	This data is calculated by the Monitoring Group

Data/Parameter # 9.3.2.6	**Microbus annual passenger turnover (mobility)**
Data unit:	Passenger/yr
Description:	Secondary data. In case of Mtskheta is calculated by data of LTD ??? and LTD Trans Didube. In 2014 suburban microbuses (6) ferried 700 passengers per day and 255 500 annually. 8 microbuses on the territory of Mtskheta ferried 800 passengers per day and 292 000 annually.
Source of data used:	Provided to SEAP by LTD ??? and LTD "Trans Didube".
Value applied:	**2014:** **Total - 547 500** **Local - 292 000 (passengers per year)** **Tbilisi-Mtskheta (on the territory of Mtskheta) -255 500**
Any comments	This parameter is used only to assess GHG emissions reductions after measures taken in the sector. The GHG annual inventory from transport sector is not dependent on it. Its verification is possible by local government because this LTD is accountable with financial parameters.

Private cars (light)

Data/Parameter #9.3.3.1	**Amount of cars registered in Mtskheta**
Data unit:	Number of vehicles
Description:	Primary data.
Source of data used:	Service Agency of MIA of Georgia. Data has been verified by SEAP group of Mtskheta Municipality
Value applied:	**2014:** Total **– 1 500** **Gasoline – 937; Diesel – 333; NG - 230.**
Any comments	

Data/Parameter #9.3.3.2	**Average distance traveled by one vehicle a year (by fuel types)**
Data unit:	km/yr
Description:	Primary data.

Source of data used:	Rated by survey of private cars that has been held by SEAP group of Mtskheta Municipality
Value applied:	24 820 km/yr
Any comments	In the future, in the monitoring process, interviews with car owners/drivers may be used. It may allow calculate average daily run and then annual run. Results of survey must satisfy criteria of statistical reliability. Interviews and surveys for calculating daily run (even annual is possible) must be held periodically together with implementation of SEAP.

Data/Parameter #9.3.3.3	**Average distance travelled by all private cars annually (by fuel types)**
Data unit:	km/yr
Description:	Calculated data.
Source of data used:	Calculated by the MUNI-EIPMP. Data # 9.3.3.1 and 9.3.3.2
Value applied:	**2014:** **Total - 37 230 000 km** **23 256 340 km (Gasoline),** **8 265 060 km (Diesel)** **5 708 600 km (NG)**
Any comments	Annual distance covered by 1 vehicle multiplied by amount of vehicles

Data/Parameter #9.3.3.4	**Fuel consumption per 100 km by fuel types**
Data unit:	l/100 km m^3/100 km Kwh/100 km
Description:	Primary data.
Source of data used:	This data must be checked with bus technical passport. For this SEAP it was provided by an independent expert according to drivers' survey.
Value applied:	Gasoline- 7.2 l/100 km Diesel- 5.61 l/100 km NG - 10.87 m^3/100 km
Any comments	Logically, this data must be verified with technical passport of private cars (by vehicle types) and must me explained in case of big difference. Big part of private cars use bad roads and that may be a reason for primary consumption specified by technical passport.

Data/Parameter #9.3.3.5	**Annual fuel consumption of private cars by fuel types**
Data unit:	l/ yr
Description:	Secondary data. Must be calculated by the Monitoring Group

Source of data used:	Calculated with MUNI-EIPMP. 9.3.3.5 = 9.3.3.1. * 9.3.3.2. * 9.3.3.4/100 Amount of cars on Gasoline multiplied by fuel cost on 100 km and multiplied by annual covered distance by 1 car and divided by 100.
Value applied:	**2014:** **Gasoline - 1 674 456 l= 15 430 MWh = 3 847 t CO_2** **Diesel - 463 670 l = 4 858 MWh = 1 285 t CO_2** **NG - 620 525 l = 5 895 MWh = 1 189 t CO_2**
Any comments	This data is calculated by the Monitoring Group and must be verified with sold fuel but quite important difference is possible. On this stage, it is calculated by Remissia that helped municipality in technical aspects of SEAP.

Data/Parameter #9.3.3.6	**Amount of passengers carried by all private cars annually**
Data unit:	passenger/ yr
Description:	Secondary data. Must be calculated by load factor
Source of data used:	This parameter was not rated during preparing Mtskheta SEAP
Value applied:	Not rated
Any comments	Amount of cars multiplied by annual covered distance and multiplied average load factor of 1 car

Data/Parameter #9.3.3.7	**Load factor of transport type**
Data unit:	Passenger.km/ trans.km
Description:	This parameter must be rated different statistical methods and surveys. SISTRA surveys for Tbilisi was used in Mtskheta SEAP
Source of data used:	This parameter was not rated during preparing Mtskheta SEAP
Value applied:	1.85
Any comments	This parameter is used only for rating GHG emissions reduced by taken measures in sector. GHG emissions from transport sector are not dependent on it.

Auto transport used by municipality

Data/Parameter # 9.3.4.1	**Number of vehicles by fuel type**
Data unit:	Number of vehicles
Description:	Primary data.
Source of data used:	Provided to the SEAP by independent local expert
Value applied:	20: (total) 20 (gasoline);
Any comments	Responsible for this data is Property Management and Planning department of the Mtskheta City Hall

Data/Parameter # 9.3.4.2	**Average distance traveled by one vehicle annually (by fuel and vehicle type)**
Data unit:	Km/yr
Description:	Primary data.
Source of data used:	Provided to the SEAP by Infrastructure, Construction and Architecture Department of the Mtskheta City Hall
Value applied:	12 775 km/yr
Any comments	

Data/Parameter # 9.3.4.3	**Average distance covered by vehicles annually**
Data unit:	Trans. km/yr
Description:	Calculated data.
Source of data used:	Calculated by the MUNI-EIPMP. Data # 9.3.4.1 and 9.3.4.2
Value applied:	255 500 km (gasoline)
Any comments	Must be verified with comparing used fuel to covered distance

Data/Parameter # 9.3.4.4	**Fuel consumption on 100 km by fuel and vehicle types**
Data unit:	l/ 100 km
Description:	Primary data.
Source of data used:	Provided to the SEAP by Economic Development and Property Ruling departments of the Mtskheta City Hall
Value applied:	Gasoline 10 l
Any comments	Responsible for this data is Economic Development and Property Ruling departments of the Mtskheta municipality. May be verified with passport data of transport type.

Data/Parameter # 9.3.4.5	**Annual fuel consumption of all auto park by fuel types**
Data unit:	l/yr m^3/yr
Description:	Secondary data. Calculated by the Monitoring Group. On this stage, calculated by Remissia.
Source of data used:	Computed by MUNI-EIPMP. 9.3.4.5=9.3.4.1.*9.3.4.2.*9.3.4.4./100
Value applied:	**2014:** **Gasoline - 25 550 l = 235 MWh = 59 t CO_2**

Any comments	Must be verified by cost of used fuel

Touristic transport

Data/Parameter # 9.3.5.1	**Amount of touristic cars in Mtskheta by fuel types**
Data unit:	Amount of touristic cars by fuel types
Description:	Primary data
Source of data used:	Provided to the SEAP by Tourism department of Mtskheta City Hall. This department has statistics of registered cars that does not give exact picture but data has been collated with other departments. Surveys and expert rates has also been made.
Value applied:	**Total – 3 000** **Gasoline - 1 874;** **Diesel - 665;** **NG - 461;**
Any comments	Responsible for primary verification of these data will be Tourism department of Mtskheta City Hall. This number must be verified during the monitoring process.

Data/Parameter # 9.3.5.2	**Average distance covered by single touristic car annually by fuel types**
Data unit:	Km/yr
Description:	Primary data
Source of data used:	For Mtskheta SEAP estimation has been made pro rata with fuel types of cars of other sector, because touristic department does not have appropriate details. But creating these data and control will be their responsibility in the future.
Value applied:	**2 920 km**
Any comments	

Data/Parameter # 9.3.5.3	**Average distance covered by all touristic cars annually by fuel types**
Data unit:	Trans.Km/yr
Description:	Calculated data
Source of data used:	Calculated by the MUNI-EIPMP. Data # 9.3.5.1 and 9.3.5.2
Value applied:	**Total- 8 760 000 km/yr** **Gasoline - 5 472 080 km/yr** **Diesel - 1 941 800 km/yr**

	NG - 1 346 120 km/yr
Any comments	On this stage, it is calculated by Remissia. Will be calculated by the monitoring group in the future.

Data/Parameter # 9.3.5.4	**Fuel consumption by transport types**
Data unit:	l/100 km m^3/100 km
Description:	Primary data
Source of data used:	Provided to SEAP by an independent expert of the Mtskheta City Hall
Value applied:	**Gasoline 9.6 l / 100 km** **Diesel 7.81 l/100 km** **NG 11.44 m^3 /100 km**
Any comments	Technical passport could be used for verifying

Data/Parameter # 9.3.5.5	**Fuel consumption by touristic cars annually by fuel types**
Data unit:	l/ km m^3/ yr
Description:	Secondary data
Source of data used:	Calculated by the MUNI-EIPMP. Data # 9.3.5.5 = 9.3.5.1. *9.3.5.2. * 9.3.5.4/100
Value applied:	**2014 = total 7 891 MWh = 1 921 t $CO_{2eq.}$** **Gasoline -525 320 l = 4 841 MWh = 1 206 t $CO_{2eq.}$** **Diesel - 151 557 l = 1 588 MWh = 420 t $CO_{2eq.}$** **NG - 153 929 l = 1 462 MWh = 295 t CO_{2eq}**
Any comments	On this stage, it is calculated by Remissia. Will be calculated by the monitoring group in the future

Data/Parameter # 9.3.5.6	**Amount of passengers ferried by alltouristic cars annually**
Data unit:	passenger/ yr
Description:	Secondary parameter
Source of data used:	Provided to SEAP by touristic department, but they does not have appropriate details. But creating these data and control will be their responsibility in the future.
Value applied:	**1 095 000 (3 000 daily)**
Any comments	This data is mainly needed for parking places and must be linked with incoming foreign transport.

Data/Parameter # 9.3.5.7	**Load factor of touristic cars with passengers**

Data unit:	Passenger.km/trans.km
Description:	This parameter must be rated with different surveys and statistical methods
Source of data used:	Has not been rated for the Mtskheta SEAP but the same factor has been used as for motor cars.
Value applied:	
Any comments	This parameter is used only for rating GHG emissions reduced by taken measures in sector. GHG emissions from transport sector are not dependent on it.

Commercial vehicles: light-duty trucks (down to 2 tons capacity)

Data/Parameter # 9.3.6.1	**Light-duty trucks driving inside Mtskheta Municipality by fuel types**
Data unit:	Number of light-duty trucks by fuel type
Description:	Primary data
Source of data used:	Provided to SEAP by an independent expert of Mtskheta City Hall
Value applied:	2 (total) Diesel- 2
Any comments	Service department of MIA and private shipping companies can be a source. Responsible for the initial verification of these data is the Mtskheta Municipality Monitoring Group.

Data/Parameter # 9.3.6.2	**Average distance traveled by one light-duty truck a year (by fuel type is recommended)**
Data unit:	km/yr
Description:	Primary data
Source of data used:	Provided to SEAP by an independent expert of Mtskheta City Hall. Information is received from the surveys of private companies and drivers.
Value applied:	10 000 km
Any comments	Responsible for the initial verification of these data is the Mtskheta Municipality Monitoring Group.

Data/Parameter # 9.3.6.3	**Average distance traveled by light-duty truck a year (by fuel type is recommended)**
Data unit:	Trans. km/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia". Data # 9.3.6.1 and 9.3.6.2
Value applied:	20 000 km in total 20 000 km (diesel)
Any comments	

Data/Parameter # 9.3.6.4	**Fuel consumption by light-duty trucks according to vehicle types**
Data unit:	l/ 100 km m^3/ 100 km
Description:	Primary data
Source of data used:	Provided to SEAP by an independent expert of Mtskheta City Hall. Information is received from the surveys of private companies and drivers.
Value applied:	Diesel- 10 l
Any comments	This data should be verified with vehicle technical passport and in case of significant discrepancy must be explained.

Data/Parameter # 9.3.6.5	**Annual fuel consumption by vehicle and fuel types**
Data unit:	l/ yr m^3/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia" 9.3.6.5=9.3.6.1*9.3.6.2*9.3.6.4/100
Value applied:	2014: 2000 l diesel
Any comments	Number of light-duty trucks powered by different types of fuel multiplied by fuel consumption per 100 km, multiplied by annual run of the track and divided by 100.

Data/Parameter # 9.3.6.6	**Light-duty trucks load factor**
Data unit:	Ton. Km/trans.km
Description:	This parameter should be evaluated by statistical methods and surveys.
Source of data used:	While developing the Mtskheta SEAP this parameter was not assessed.
Value applied:	Not estimated.
Any comments	Essential in calculations of measures taken

Data/Parameter # 9.3.6.7	**Transported freight by all light-duty trucks in a year (annual freight turnover)**
Data unit:	Ton. km/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia".
Value applied:	Not assessed.
Any comments	Number of light-duty trucks (<2 ton capacity) multiplied by their annual run, multiplied by transported freight per one vehicle (ton).This parameter can by verified through freight actually transported and the relevant run by vehicles.

Commercial transport (Heavy-Duty Trucks up to 2 ton capacity)

Data/Parameter # 9.3.7.1	**Number of heavy duty trucks operating in Mtskheta Municipality**
Data unit:	Number of heavy-duty trucks by fuel type
Description:	Primary data.
Source of data used:	Provided to SEAP by an independent expert of Mtskheta City Hall. Information is received from the surveys of private companies and drivers.
Value applied:	2014: 16 (total) 12 (diesel) 4 (NG)
Any comments	Service department of MIA can be a source. Responsible for the initial verification of these data is the Mtskheta Municipality Monitoring Group.

Data/Parameter # 9.3.7.2	**Average distance covered by one heavy-duty truck a year (by fuel type is recommended)**
Data unit:	Km/yr
Description:	Primary data.
Source of data used:	Provided to the SEAP by independent local expert on the basis of questioning among private companies and expert judgement.
Value applied:	18 250 km/yr
Any comments	Primary verification of these data will be a responsibility of the City Hall Monitoring Group.

Data/Parameter # 9.3.7.3	**Average distance covered by all heavy-duty truck a year (by fuel type is recommended)**
Data unit:	Trans. km/yr
Description:	Calculated data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia". Data # 9.3.7.1 and 9.3.7.2
Value applied:	**Total 2014- 292 000 km/yr** **Diesel - 219 000 km/yr** **NG - 73 000 km/yr**
Any comments	

Data/Parameter # 9.3.7.4	**Fuel consumption by vehicle type**
Data unit:	l/ 100 km m^3/ 100 km
Description:	Primary data.
Source of data used:	Technical passport of the vehicle. Provided to the SEAP by SEAP group of

	Mtskheta Local Government. Source – survey of private companies
Value applied:	**Diesel - 27 l/100 km** **NG - 30 m^3/100 km**
Any comments	

Data/Parameter # 9.3.7.5	**Annual fuel consumption according to vehicle and fuel types**
Data unit:	l/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia".
Value applied:	**2014:** **Diesel - 59 130 l = 619 MWh = 164 t CO2** **NG - 21 900 m^3 = 208 MWh = 42 t CO2**
Any comments	

Data/Parameter # 9.3.7.6	**Heavy-duty trucks load factor**
Data unit:	Ton. Km/car. km
Description:	Primary data.
Source of data used:	While developing the Mtskheta SEAP this parameter was not assessed
Value applied:	Not estimated
Any comments	Required to assess emissions saving from measures implemented during the monitoring period.

Data/Parameter # 9.3.7.7	**Transported freight by all heavy-duty trucks in a year (annual freight turnover)**
Data unit:	Ton. km/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia"
Value applied:	Not assessed
Any comments	These parameters could be verified via actual annually transported freight and relevant total run of trucks.

Data/Parameter # 9.3.7.8	**Total amount of fuel consumed in Mtskheta Municipality Transport sector by fuel types**
Data unit:	l/yr (Mwh) m^3/yr (Mwh)
Description:	Secondary data calculated during the monitoring and SEAP development process
Source of data used:	Calculated by the SEAP tean ("Remissia") using emissions growth index derived by the EU Research Center.

Value applied:	**Consumed in 2014:** **Totak fuel - 36 007 MWh = 8 716 t $CO_{2eq.}$** **Forecast for 2020:** **Total emission - 12 228 t $CO_{2eq.}$**
Any comments	This is one of the most important data for balance verification during the monitoring process.

Monitoring on planned measures in Mtskheta Transport sector

Measure #PT1	**Creating public transport in Mtskheta (buses on NG or electric buses)**
Implementation date	**2018-2025**
Description	There are 8 local and 6 Tbilisi-Mtskheta microbuses in Mtskheta that move everyday. Each of them covers 80 km daily in Mtskheta on average. Local government plans to replace existing microbuses with ecologically cleaner and more comfortable buses and there will be 6 (33-placed) buses instead of them by 2020. NG and electricity are considered as their fuel. Emission reductions are calculated for both of them. Fuel consumption per one bus (NG) is 20 m^3/100 km or 100 KWh/100 km (electricity). In case of strict parking rules in Mtskheta, this transport will reduce movement of private cars presumably by 10%. At this stage, one microbus on the territory of Mtskheta covers 29 200 km annually. Existing 14 microbuses carry 584 000 passengers annually (1 600 daily). In case of implementation of the measure, these 6 new buses will be able to carry the same amount of passengers. Distance covered daily by one bus will not change and they will move in every 20 minutes for 10-12 hours per day. If 10% of private car users decide to use new buses, it will increase number of passengers per day and it will reach 1 900. This measure is planned for 2020 but there is a chance that the time left will not be enough, because construction of bridge over river Mtkvari is more important and expensive, too. In case of this measure, 678.21 t CO_2 (in case of NG) or 727.11 t CO_2 (in case of electricity) will be saved annually by 2020.
Indicators that must be monitored	• Number of passengers carried per day • Number of municipal buses • Distance covered daily by one bus • Fuel consumption by buses per 100 km (by fuel types)
Amount of reduced emissions reached in the period of monitoring	Described measure will reduce 678.21 t CO2eq. (5.51% of forecast total emission in 2020) emissions in case of NG buses and 727.11 t CO2eq. (5.9% of forecast total emission in 2020) - in case of electric buses.

Any comments	
Responsible structure	Department of infrastructure, architecture and construction of Mtskheta City Hall with LTD "Ketilmotskobis Samsakhuri". New appropriate transport LTD will be formed

Measure #PT2	**Setting new runs for tourists in Mtskheta by electric transport**
Implementation date	**2019-2025**
Description	Municipal government of Mtskheta plans in this small and beautiful, clean city to decongesting traffic from tourist vehicles, for which on the left bank will setup parking areas, where incoming foreign / non-local transport will stop and from there will run electric buses, which provide the movement and all the tours in the city . According to the information into the city every day come about 3000 tourists, whom serve gasoline-powered - 1 874 different types of cars, diesel-powered - 665 cars and natural gas-powered - 461 machine. By currently available information,3000 turist visits the city daily by touring and other types of cars. To serve this number of tourists in the service territory of the city will require an additional 8 buses (3 000 tourists / 33 the number of passengers per bus / 12 h), which will serve visitors from the parking place in the entrance to and in the city. Buses will depart every once in 7 minutes and and will cover 4-5 km in thecity in 30 minutes.
Indicators that must be monitored	• Number of passengers carried per day • Number of municipal buses • Distance covered daily by one bus • Fuel consumption by buses per 100 km (by fuel types)
Amount of reduced emissions reached in the period of monitoring	In case of implementation of this measure 1 831 t CO2 emissions will be saved by 2020 in case of electric buses.
Any comments	
Responsible structure	Department of infrastructure, architecture and construction of Mtskheta City Hall with LTD "Ketilmotskobis Samsakhuri". New appropriate transport LTD will be formed

Measure #UP1	**Road rehabilitation in Mtskheta**
Implementation date	**2015 - 2025**
Description	Mtskheta municipal area is 6 500 km2 in total.There are 50 streets and 8 dead-end in the city in total. Total length of the streets is 100 km. Central street length (Narekvavi - Mtskheta - railway station) is 8 km. 70 km from

	total road surface is covered with asphalt, but 57% of its absorbed, 5% of roads covered with gravel, and the remaining 25% of the needs asphalt paving. On these absorbed streets moves approximately 95% of the city's overall transport and only 5% moves on the good road. In recent years, there is significant progress in the development of road infrastructure and road paving terms. In the city there was covered and wellorganized road 15 km in total in 2012-2013 years. In 2015 across the municipality was laid 5 km and 10 km were laid in 2016. 70% of the road surface is fully rehabilitative . On the 30% of rehabilitative road is needed to be asphalte, while 40% of already asphalted road is needed fully cover replacement of absorbed surface. Thus,in case of the complete rehabilitation of the roads emission from moving transport sector in the Mtskheta area, as the surveys show, could be reduce at least by 6%, from 70% of rehabilitative roads by 2020. 8 716 t emission in CO2 - equivalent emerges from the transport moving on the Mtskheta teritory annually in total. 95% of it (8 280 t CO2-equivalent) is formate from absorbed and unpaved roads. In case of fully reabilitation of 70% of absorbed roads, will be conserved 348t CO2-equivalent emmision (8 280*0.7*0.06)
Indicators that must be monitored	• Total lenth of asphalted roads; • Fuel consumption per 100 km by one car (by types) on non-asphalted road; • Fuel consumption per 100 km by one car (by types) on asphalted road;
Amount of reduced emissions reached in the period of monitoring	348 t CO2eq. emission will be saved annually as a result of this measure
Any comments	According to different sources, this measure contains big inaccuracy, as emission is outmoded even during asphalting and reconstructing roads. But it must be also mentioned that in the long-term perspective (average viability of a road is 10 years), amount of pollution is much more than during asphalting/reconstructing it.
Responsible structure	Department of Spatial Planning Infrastructure, Architecture and Construction of Mtskheta City Hall

Measure #UP2	**Construction of 2 additional bridges over river Mtkvari**
Implementation date	**2019 - 2022**
Description	This measure includes optimization of transport routes for shortening distances. Concretely, construction of 2 additional bridges over river Mtkvari is planned. "Bridge 1" will unload movement of local residents at least by 50% and movement of tourists at least by 30%. Parking territory will be created on the left shore of the river. "Bridge 2" will be a pedestrian bridge with the length of 100 meters over Mtkvari that will end near Svetitskhoveli cathedral and will ussually serve to

	parish and tourists. Parking will be created near it, too. It will unload their movement approximately by 30%, especially at the religious holidays.
Indicators that must be monitored	• Changing trend of road traffic • Fuel consumption of a single car during covering loaded road and consumption during covering the same clear distance
Amount of reduced emissions reached in the period of monitoring	With this measure ("Bridge 1") emission savings will reach 3 267 t CO2eq. annually until 2020 just by reducing distance covered by local residents by 50%. Its details are available in the monitoring plan.
Any comments	Effect of this measure will be especially high in case of more strict politics about parking in the city. At this stage, final plan of the measure is not available yet and probably, it is planned in the long-term perspective (after 2025). Revision of this measure and calculation its emissions will be in a renewed action plan for 2020-2030.
Responsible structure	Department of infrastructure, architecture and construction of Mtskheta City Hall.

Measure #PRT1	**Parking in Mtskheta**
Implementation date	**2018 -2030**
Description	Mtskheta municipality already has parking policy, but it is more directed to touristic transport. Once a year, at Svetitskhovloba holiday, when there is a huge crowd of parish in Mtskheta, it closes for cars and movement is only available for pedestrians or municipal transport. For reducing GHG emissions and development of tourism, local government plans stricter parking policy in the city and creating valuable parking places in the centre of the city for private cars and taxis. Actually, construction of parking areas is one of the main priorities of the strategy. Setting of new parking areas around the city is described in measure UP2. About 4 581 different transport moves in Mtskheta daily that consume 36 607 MWh/yr energy per year and creates 8 716 t CO2eq. GHG emissions. 12 228 t CO2eq. emission is expected by 2020 after this measure. According to the literature about reducing emissions from transport sector, every single car reduces about 7-10% of moving distance, where there is a parking space. An approach has been made for Mtskheta that this reduction will be 7% and for only private light-duty cars (96% of whole auto park) including that this shares will remain in the future. According to this approach, in case of implementation of this measure, emission reduction from private light-duty and commercial cars will be 457 t CO2eq. by 2020.

Indicators that must be monitored	• Amount of parking lots • The distance covered by private cars annually (survey). • Share of restricted parking area in city area • Fuel consumption by single car per 100 km
Amount of reduced emissions reached in the period of monitoring	With an approach that emission from private light-duty and commercial cars will be at least 96% of total emission, against which, according to the estimations, this measure has the biggest impact, 6 533 t CO2eq. emmisions from this sector will be reduced by at least 7% (457 t CO2eq. annually).
Any comments	
Responsible structure	Department of infrastructure, architecture and construction of Mtskheta City Hall and Local Government.

Measure #PRT2	**Helping pedestrians, tourists and cyclists in Mtskheta**
Implementation date	**2018 - 2025**
Description	In small towns cycling and walking is one of the most effective and importantly healthy alternative way of moving. However, it has significant barriers, one of the main barrier is population attachment to their vehicles and definig it as a social status determine criterion. That's why it is important to overcome the stereotypes and promote pedestrians and ciclist more. For the popularization of this way of moving, city authority should conduct campaigns to promote moving by bike and on foot as a modern, European and effective approach to maintaining a healthy environment, as well as in terms of movement. In this process especially important for those interested in walking and bicycling is to develop comfortable infrastructure especially in tourist areas. In order to facilitate the pedestrians Mtskheta Municipal Hall will continue sidewalks and crosswalks arranging events, walking to be comfortable and safe. Will be provided to improve the conditions for the movement of people with disabilities. At this time the municipality has no specific plan, but it is planning to do so in the near future. 7 km of cycling lanes arrangement is plannde in Mtskheta. This event is not counted separately to reduce emissions, but City Hall is aware, that such measures are important to the whole process and sustainable urban development. In particular, comfortable cycling and hiking paths is necessary in strict parking conditions and in order to limit the tourist traffic from entering the city and increase environmentally friendly transport.
Indicators that must be monitored	• Length of pedestrian roads in 2025 and 2030; • Increase of pedestrians (surveys before and after the measure); • Average distance covered by a single pedestrian before and after

	measure (survey and researches); • Length of bycicle roads in 2025 and 2030; • Increase of cyclers (surveys before and after the measure); • Average distance covered by a single cycler before and after measure (survey and researches);
Amount of reduced emissions reached in the period of monitoring	Emission reduction of this measure has not been calculated, but the City Hall realizes that these kinds of measures are important for the whole process and for sustainable development of the municipality.
Any comments	Organizing some events for increasing level of social habits is very important for successful implementation of the measure. It must be described, what are the opportunities of pedestrians and cyclers against drivers. Especially for attracting tourists.
Responsible structure	Department of infrastructure, architecture and construction of Mtskheta City Hall and Local Government.

9.4 Buildings

Baseline Emissions Monitoring

Data/Parameter # 9.4.1	**Areas of municipal buildings according to their purpose (kindergartens, administrative, etc.)**
Data unit:	m^2
Description:	Primary parameter
Source of data used:	Mtskheta Municipality
Value applied:	Total- **13 173** Kindergartens- **2 354** Municipal buildings- **10 819**
Any comments	Information possessed by the Property ruling department of the Municipality

Data/Parameter # 9.4.2	**Annual consumption of electric energy by municipal buildings**
Data unit:	MWh/yr
Description:	Primary parameter.
Source of data used:	The Mtskheta City Hall Finance Department.
Value applied:	Total- 377 Kindergartens- 26 Other municipal buildings- 351
Any comments	These data should be revised at the Energo-Pro distribution company and by energy audit assessments.

Data/Parameter #	**Areas of the Mtskheta residential buildings by types (one and two-**

9.4.3	**storey private houses, multi-storey buildings, etc.**
Data unit:	m^2
Description:	Primary parameter.
Source of data used:	Provided to the SEAP by an independependent expert of Mtskheta City Hall and by auditors of Buildings Sector of SEAP
Value applied:	Total- **105 307** Residential buildings- **26 371** Private dwelling houses- **78 936**
Any comments	Information is mainly based on expert rates and surveys

Data/Parameter # 9.4.4	**Annual energy consumption by residential buildings according to their types**
Data unit:	MWh/yr
Description:	Primary parameter.
Source of data used:	Information is mainly based on expert rates and surveys, foreseeing areas
Value applied:	Total- **2 845** Multi-storey – **569** Private - **2 276**
Any comments	As Mtskheta became an independent city in 2014, Energo-Pro could not give the information about residential and commercial buildings in Mtskheta. These data is least trustworthy and needs an improvement. City Hall must actively collaborate with Energo-Pro for this.

Data/Parameter # 9.4.5	**Total area of commercial buildings in Mtskheta Municipality**
Data unit:	m^2
Description:	Primary parameter.
Source of data used:	Provided to the SEAP by an independependent expert of Mtskheta City Hall and by auditors of Buildings Sector of SEAP
Value applied:	Total- 5**51 943** Schools- **36 059** Other commercial buildings- **15 884**
Any comments	Information is mainly based on expert rates and surveys

Data/Parameter # 9.4.6	**Annual electricity consumption by commercial buildings**
Data unit:	MWh/yr
Description:	Primary parameter.
Source of data used:	Information is mainly based on expert rates and surveys, foreseeing areas

Value applied:	Total – 379 Schools – 50 Other commercial buildings - 329
Any comments	As Mtskheta became an independent city in 2014, Energo-Pro could not give the information about residential and commercial buildings in Mtskheta. These data is least trustworthy and needs an improvement. City Hall must actively collaborate with Energo-Pro for this.

Data/Parameter # 9.4.7	**Annual consumption of natural and liquid (LPG) gas by municipal buildings**
Data unit:	m^3/yr; kg/yr (MWh/yr)
Description:	Primary parameter.
Source of data used:	Information is mainly based on expert rates and surveys, foreseeing areas
Value applied:	**Total - 195 776 m^3- 1 903 MWh/yr** **Kindergartens - 50 937 m^3** **Other commercial buildings - 144 839 m^3**
Any comments	Could be verified at the gas supply company.

Data/Parameter # 9.4.8	**Annual consumption of natural and liquid (LPG) gas by residential buildings**
Data unit:	m^3/yr; kg/yr (MWh/yr)
Description:	Primary parameter.
Source of data used:	Information is mainly based on expert rates and surveys
Value applied:	**Total NG - 2 969 938 m^3/yr - 26 255 MWh/yr** **Multi-storey -468 686 m^3** **Private houses - 2 231 844 m^3**
Any comments	Could be verified at the gas supply company.

Data/Parameter # 9.4.9	**Annual consumption of natural gas by commercial buildings**
Data unit:	m^3/yr; (MWh/yr)
Description:	Primary parameter (annual).
Source of data used:	Information is mainly based on expert rates and surveys
Value applied:	**NG - total 322 645 m^3 – 3 137 MWh/yr** **Schools - 118 673 m^3** **Other commercial/non-residential buildings - 203 972 m^3**
Any comments	This data could be verified by the questioning of commercial buildings and energy audit assessments. This data is not exact and needs to be recalculated.

Data/Parameter # 9.4.10	**Annual consumption of liquid gas (LPG) and diesel by municipal buildings**

Data unit:	l (MWh/yr)
Description:	Primary parameter.
Source of data used:	Information is mainly based on expert rates and surveys
Value applied:	Not applied.
Any comments	

Data/Parameter # 9.4.11	**Annual consumption of firewood in municipal buildings**
Data unit:	m^3
Description:	Primary parameter.
Source of data used:	Mtskheta City Hall
Value applied:	Not applied.
Any comments	

Data/Parameter # 9.4.12	**Annual consumption of firewood in residential buildings**
Data unit:	m^3
Description:	Primary parameter.
Source of data used:	Given vouchers to the population. Eventual quality of data is under the responsibility of Mtskheta Municipality
Value applied:	**100 m^3 – 285 MWh/yr**
Any comments	According to the data gathered from the City Hall, level of firewood consumption is too low.

Data/Parameter # 9.4.13	**Annual consumption of firewood in other buildings**
Data unit:	m^3
Description:	Primary parameter.
Source of data used:	According to the data gathered from the City Hall, at the present stage firewood is not used in commercial buildings and schools
Value applied:	Not applied.
Any comments	

Data/Parameter # 9.4.14	**Annual consumption of diesel by commercial buildings**
Data unit:	M^3 (MWh/yr)
Description:	Primary parameter (annual).
Source of data used:	Questioning of commercial buildings. Mtskheta City Hall is responsible for the final quality of data.
Value applied:	At present stage diesel is not used in commercial buildings, although monitoring is necessary.
Any comments	This data could be verified by the questioning in commercial buildings.

Data/Parameter # 9.4.15	**Annual monitoring of CO_2 emission from all three sub sectors (municipal, residential and commercial)**
Data unit:	tCO_2/yr
Description:	Secondary parameter (annual).
Source of data used:	Calculated by the Monitoring Group.
Value applied:	2014 baseline year- **6 799** 2020 year- **9 200** (projected).
Any comments	

Monitoring of planned activities in the building sector

Activity #MB2.1; MB 2.2;	Replacing old lamps with new energy effective lamps in municipal buildings
Planned implementation (dates)	**2017-2020**
Description of activity:	The aim of an activity was installation of energy effective lighting system in municipal buildings and that is why one building (House of Culture and Sports of Mtskheta) has been estimated and it was found out that saving on 1 m^2 is 2.5 W and lamps will be replaced in the area of 10 819 m^2. 675 lamps are needed for that. 270 lamps will be replaced in kindergartens.
Indicators to be monitored	• Amount of replaced lamps, capacities of old and new lamps • Electricity consumption of building/system before and after replacing of lamps • Annual working duration (in hours) before and after replacing • Ensuring of lighting standard - satisfactory
Amount of reduced emission, achieved during the monitoring period	8.47 t CO_{2eq}. will be saved in total
Any comments	
Implementing body	Agency of kindergarten ruling of Mtskheta Municipality.

Activity #MB3.1	**Using sun collectors in kindergartens**
Planned implementation (dates)	**2018-2019**
Description of activity:	Aim of this measure is to use sun collectors for delivering hot water in municipal buildings like kindergartens and schools. Nowadays, 4 000 l of hot water is being spent in these buildings every day that is equal to 25 200 KWh electricity. Sun collector in Mtskheta produces 1 050 KWh/m^2 per year. In case of using vacuum sun collectors that are installed on the roof, 25 200 KWh energy could be produced on 24 m^2 per year.

	Area of standard sun collector is 2 m^2 and costs 1 300 GEL. In case of Mtskheta 12 collectors will be needed that will cost 15 600 GEL.
Indicators to be monitored	• Areas of installed sun collectors (m^2) • Consumed thermal energy (measured) • Amount of consumed hot water (l) and its temperature (measured)
Amount of reduced emission, achieved during the monitoring period	For gaining this energy (25 200 KWh/yr) 25 200/(9.4x0.9)=2 978 m^3 natural gas is needed that is equal to 2 978x0.82=2 442 GEL. In case of replacing natural gas with solar energy, reduction of CO_2 emissions will be 25 200x0.202/1000=5.1 t CO_2 per year
Any comments	In case of 5 kindergartens, savings will be 25.5 t CO2 per year
Implementing body	LTDs "Ketilmotskobis Samsakhuri" and "Mtskhetis Meriis Bagebis Gaertianeba"

Activity # RB 2.1	**Activities mainly implicate window covering, reduction of infiltration from windows**
Planned implementation (dates)	**2018-2020**
Description of activity:	As a part of the measure, 9 534 m^2 windows must be caulked up on 59 buildings.
Indicators to be monitored	• Total area of covered windows; • Total area of new windows; • Energy consumption reduction on covered area (window) unit and area of new window unit; • Must me rated or chosen these sizes rated in other countries; • Natural gas (other fuel) consumption before and after the activity; • Room/heated area daily temperature before and after the activity; • Area to be heated before and after the activity;
Amount of reduced emission, achieved during the monitoring period	Energy reduction will be 1 161 MWh/yr and CO2 emissions reduction – 234 t CO2eq.
Any comments	Total cost of the activity is 19 068 GEL
Implementing body	Other (NGOs, communities, municipality, etc.)

Activity # MB1.1; MB 1.2; RB 1.1; RB 1.2	**Ceiling covering**
Planned implementation (dates)	**2017-2020**
Description of activity:	This activity includes thermal isolation of ceiling (4 050 m^2 in total) of every municipal building in Mtskheta (on example of House of Culture and Sports of Mtskheta), the same action in 5 kindergartens (265 m^2), 62 residential buildings

	(24 288 m^2) and 500 private houses (78 m^2 on average).
Indicators to be monitored	• Area of heated ceiling; • Natural gas (other fuel) consumption for heating before and after the activity; • Daily temperature in the room before and after the activity; • Total amount of children and staff in kindergartens before and after the activity; • Area to be heated before and after the activity;
Amount of reduced emission, achieved during the monitoring period	As a result of all 4 activities, total annual emission savings will be 1 244 t CO_{2eq}. for 2020.
Any comments	Total cost of the activity is 1 392 060 GEL.
Implementing body	Other (NGOs, communities, municipality, etc.)

9.5 Street Lighting

Data/Parameter # 9.5.1	**Annual amount of electricity consumed for street lighting**
Data unit:	KWh/yr
Description:	Primary data
Source of data used:	LTD "Ketilmotskobis Samsakhuri" ,which is responsible for the registration and delivery of monthly/annual data on the amount of street lamps.
Value applied in SEAP:	948 403 KWh (in 2014) 1 153 000 KWh (projection for 2020)
Any comments	This data should be verified by the paid expenses. The projection for 2020 is calculated by the SEAP developing group.

Data/Parameter # 9.5.2	**Carbon dioxide emission from street lighting sector**
Data unit:	tCO_2/yr
Description:	Secondary data
Source of data used:	Calculated by the Monitoring Group
Value applied in SEAP:	100 t CO_2eq (2014) 120 t CO_2eq (projection for 2020)
Any comments	

Data/Parameter # 9.5.3	**Amount of street lamps in Mtskheta Municipality**

Data unit:	Quantity
Description:	Primary data
Source of data used:	LTD "Ketilmotskobis Samsakhuri" ,which is responsible for the registration and delivery of monthly/annual data on the amount of street lamps.
Value applied in SEAP:	1 614 (in 2014) 1 921 (projection for 2020)
Any comments	On this stage there is incandescent lighting in the municipality

Data/Parameter # 9.5.4	**Duration of lamp/street lighting or evaluable system**
Data unit:	H/day or h/yr
Description:	Primary data
Source of data used:	LTD "Ketilmotskobis Samsakhuri"
Value applied in SEAP:	12 h/day 4 380 h/yr
Any comments	

Data/Parameter # 9.5.5	**Grid effectiveness in the Mtskheta Municipality**
Data unit:	KWh/yr consumed averagely by one lamp
Description:	Secondary data
Source of data used:	Calculated by Remissia
Value applied in SEAP:	In 2014 – 588 KWh/yr (one lamp consumes 134 W per hour) 2020 – 96 (as a result of the activity one lamp will consume 22 W per hour)
Any comments	

Monitoring on planned measures in Mtskheta street lighting sector

Activity S1	**Replacing blaze lamps with energy effective LEDS lamps**
Planned implementation (dates)	**2016 - 2025**
Description of activity:	It is understood that the event will begin in 2016 and will be replaced with energy-efficient LED lighting to the current 1 614 inefficient traditional lighting gradually in the years 2016-2020. In addition, the remaining streets lights 15% will light up with effective lamp. It turns out that the total number of lamps to be replaced 1 614 / 0.85 + 30 = 1 929 lamp, the new lamps amount is 1 929 - 1 614 = 315. If you're lighting point by the average energy consumed 0,136 kW per hour and continued lighting services currently used lamp types of the 2020 annual energy consumption of street lighting system in Mtskheta will be 1 929 (lighting) * 0.136 (kW) * 4 380 (h) = 1 152 971 kWh, while the using the energy-efficient LED bulbs over the network the annual energy consumption will be 1 929 (lighting) * 0.036 (average kW) * 4 380 (h) = 300 226 kWh Therefore energy savings in 2020

	would be 1 152 971 - 300 226 = 852 745 kWh of electric power, and the reduction of emissions in accordance with (1 152 971 - 300 226) / 1 000 * 0,104 = 88.69 tons of CO2 eq. Since the average cost to replace a lamp is 320 GEL and the new lights in an average of 800 GEL, the events cost comes out to about 1 614 * 320 + 315 * 800 = 768 480 GEL.
Indicators to be monitored	• Amount of lighting points by types • Annual time of lighting (h/yr) • Average usage of a single lamp
Amount of reduced emission, achieved during the monitoring period	Reducing CO_2 emissions by 89 t in 2020
Any comments	
Implementing body	LTD „Ketilmotskobis Samsakhuri" of Mtskheta

Activity S2	**System of remote control and economic use of lighting**
Planned implementation (dates)	**2020**
Description of activity:	On Mtskheta teritory will be arranged the lighting remote control and efficient useage system. It is understood that the event will start after installing additional lamps (after 2018) and will continue in the years 2018-2020. Implementation of this measure, energy will be saving by using the remote control for regulating street light system. There will be controller's office for managing outdoor lighting control system: the night-time lighting will be lower, will be turned of one other passing and ect. It is planned that by the year 2020 in the above system is expected to be involved Mtskheta mainc streets and neighbours. Other countries have taken similar measures an average of 40% to 60% energy savings possible.
Indicators to be monitored	• Amount of lighting points by types • Annual time of lighting (h/yr) • Average usage of a single lamp
Amount of reduced emission, achieved during the monitoring period	Energy reduction will be 120 MWh/yr and CO2 emissions reduction – 12.5 t CO2eq. for 2020.
Any comments	
Implementing body	LTD "Ketilmotskobis Samsakhuri" of Mtskheta.

9.6 Greening

Baseline Emissions Monitoring

Data/Parameter #	**Total planted area in the Mtskheta Municipality(2014)**

9.6.1	
Data unit:	ha Number of plantings by species
Description:	Primary parameter
Source of data used:	LTD "Ketilmotskobis Samsakhuri"
Value applied:	258 ha are covered by plants within the limits of the municipality
Any comments	It includes private gardens of residents

Data/Parameter # 9.6.2	**Annual removal of carbon dioxide from the Mtskheta territory under the baseline conditions of 2014 greening**
Data unit:	tCO_2/yr
Description:	Secondary parameter
Source of data used:	Calculated through the SEAP development process
Value applied:	Annual removal- 561 tCO_2/yr. Amount of sequestered carbon in 2014 at the whole territory of 258 ha equals to 4 069.5 tC.
Any comments	

Data/Parameter # 9.6.3	**Annual cutting/ trimming of trees by species**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	LTD "Ketilmotskobis Samsakhuri"
Value applied:	Trees are being trimmed every year Approximate reduction of biomass as aresult of trimming – 20 m^3
Any comments	Trimmings should be considered in the monitoring process.

Data/Parameter # 9.6.4	**Annual fires or other causes of damage to trees**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	LTD "Ketilmotskobis Samsakhuri"
Value applied:	Fires should be considered in the monitoring process.
Any comments	

Data/Parameter # 9.6.5	**Annual monitoring about change of CO_2 absorption**
Data unit:	t CO_2 per year
Description:	Secondary parameter. Calculated by monitoring group
Source of data used:	At this stage, calculated by SEAP group
Value applied:	After implementing different measures, 5 042.4 t C (18 488.8 t CO_2) will be reserved for 2020.

Any comments	

Monitoring of carbon sequestration increase resulting from the adoption of measures

Activity #G1	2000 samplings planting on 1 ha
Planned implementation (dates)	**2015-2016**
Description of activity:	In total 2000 trees of lime-tree and soap tree seeds were planted, on Mtsketa's green zones with different purposes, which took 1 ha. At this time planted seedlings are 100% cultivated.
Indicators, according to which the monitoring should be performed	• Species planted by area • Area covered by Chron • Usage of fertilizer • Logging and fires
Amount of reduced emissions, got through the monitoring period	An area covered with new plantations will absorbs 43.3 tons of carbon dioxide by the year 2020, while the accumulation will be 11.8 tons of carbon. The absorption of carbon dioxide will reach 115.4 tons for 2030, and 31.5 tons of carbon accumulation.
Comments	
Implementing body/unit	LTD "Ketilmotskobis Samsakhuri" of Mtskheta Municipality

Activity #G2	On the vicinity of acting hall 15 ha would be greened in total in Mtskheta
Planned implementation (dates)	**2016-2030**
Description of activity:	In Mtskheta in the vicinity of the acting hall 20 hectares is planned to be arranged (1.33 ha in the greening and arranging infrastructure per year) Recreation Zone, particularly the forest park in stages. Overall the plants cultivating works are foreseen on 15 ha-s, while the remaining 5 ha of land intended to arrange different types of infrastructure (roads, paths, lawns, etc.). For planting was selected a few species of wood plants: asp, maple, lime-tree, Paulownia, oak of grove, willow, mulberry, tuya, lugustrumi. It should be noted that near the river, where the groundwater level is high, it is recommended to be planted asp, willow trees and various species of oak grove
Indicators, according to which the monitoring should be performed	• Species planted by area • Area covered with new plantation • Planted tree species by age • Area covered by Chron • Usage of fertilizer • Logging and fires
Amount of reduced emissions, got through the monitoring period	An area covered with new plantations will absorbs 158.0 tons of carbon dioxide by the year 2020, while the accumulation will be 43.1 tons of carbon. The absorption of carbon dioxide will reach 1182.9 tons for 2030,

	and 322.6 tons of carbon accumulation.
Comments	Implementation cost 2 604 270 GEL (1 108 200 USD)
Implementing body/unit	LTD "Ketilmotskobis Samsakhuri" of Mtskheta Municipality

9.7 Waste

Baseline Emissions Monitoring

Data/Parameter # 9.7.1	**Parameters of Mtskheta Municipality landfill**
Data unit:	Area, ha; Depth, m.
Description:	Primary data.
Source of data used:	During the SEAP development process data has been provided by the LTD Communal Farming which should remain the main source of information through the monitoring process, as well.
Value applied:	Total area- 7.5 ha and the depth- more than 5 m.
Any comments	Waste from Mtskheta is being carried to Kaspi Municipality landfill

Data/Parameter # 9.7.2	**Daily amount of waste originated in Mtskheta**
Data unit:	m^3 or ton
Description:	Primary data.
Source of data used:	During the SEAP development process data has been provided by the Mtskheta Municipality which should remain the main source of information through the monitoring process, as well.
Value applied:	2 400 – 3 200 t of waste is originated annually from the Mtskheta Municipality itself in 2015
Any comments	

Data/Parameter # 9.7.3	**Composition of waste**
Data unit:	%
Description:	Primary data
Source of data used:	In May 2015, in Georgia, Shota Rustaveli National Science Foundation launched a project "The Number of Solid Domestic Waste Accumulation and Morphological Composition Determination Methodology and Database in Georgia". The project is carried out by the Technical University Institute of Hydrometeorology. Solid waste composition data provided by the project.
Value applied:	Consistency of waste (%) : Population: food 43.89 %, textile/leather 1.81%, paper 9.93%, hygienic wastes 5.95%, plastic 37.78%. Visitors: food 44.68%, textile/leather 0.1%, paper 20.73%, hygienic wastes 2.45%, plastic 25.58%.

Any comments	

Data/Parameter # 9.7.4	**Trend of generated methane**
Data unit:	m^3 or t
Description:	Secondary data. Amount of generated methane must be calculated by model of first level of rot. Responsible for it is a monitoring group.
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (p. 3.36) this is prepared software.
Value applied:	Besides consistency of waste, model is given next parameters: Correction coefficient of methane emission (MCF) – 1 Organic carbon with the ability to rot DOC Consistency of wastes Food wastes 0.15 Garden 0.20 Paper 0.40 Wood and straw 0.43 Textile 0.24 Throwaway towels 0.24 • Rotten share of organic carbon with the ability to rot (DOCF) - 0.6; • Share of methane in landfill gas (F) – 50%; • Rusting coefficient (OX) – 0 (at controlled landfill) Results: **2014 -1.45 gg CO2eq;** **2020 - 2.22 gg CO2eq;** **2030 - 3.52 gg CO2eq;**
Any comments	Forecast of emissions from used water for 2020 is based on an approach that population increases by 0.5% annually and amount of waste at landfill grows by 2.5% annually.

Monitoring of emissions reduction, resulting from measures implemented

Activity #W1	**Reduction of paper, plastics and glass content in the waste due to preliminary separation**
Planned implementation (dates)	2017-2020
Description of activity:	In Tbilisi, in the Orkhevi Settlement currently functions the paper processing mill, producing toilet paper. Setting up of paper processing facility in Tbilisi and the regions has facilitated the process of collecting and handing over of secondary paper. The leading position in this process belongs to state agencies (ministries, City Halls, schools, etc.). Consequently the mentioned fraction in overall waste composition is being decreased, causing corresponding reduction in the generation of methane from the landfill. According to the national strategy of waste management (2016-2030), separation of solid waste is planned and appropriate reductions are given in the table below for 2020, 2025 and 2030.

	<table><tr><th>Solid Residential Waste (SRW) fraction</th><th>2020</th><th>2025</th><th>2030</th></tr><tr><td>Paper</td><td>30%</td><td>50 %</td><td>80%</td></tr><tr><td>Glass</td><td>20%</td><td>50%</td><td>80%</td></tr><tr><td>Metal</td><td>70%</td><td>80%</td><td>90%</td></tr><tr><td>Plastic</td><td>30%</td><td>50%</td><td>80%</td></tr></table>
Indicators, according to which the monitoring should be performed	Only basic indicators that must be monitored in case of implementation are given here • Share of paper in total waste after project implementation; • Share of plastic in total waste after project implementation; • Share of glass in total waste after project implementation; • Amount of originated waste per capita/total; • Amount of separated and recycled paper (kg); • Amount of separated and recycled plastic (kg); • Amount of separated and recycled glass (kg);
Amount of reduced emissions, got through the monitoring period	According to primary estimations, methane emission will be reduced by 1.08% by 2020 and 12.10% by 2030.
Comments	
Implementing body/unit	This is a planned measure and presumably, Mtskheta Municipality will be its executive structure.

Monitoring of baseline level emissions of used water

Data/Parameter # 9.7.5	**Population of Mtskheta Municiaplity**
Data unit:	1000 persons
Description:	Primary Data
Source of data used:	During preparing SEAP data has been provided by Mtskheta Municipality and verified on http://geostat.ge that must be a main source.
Value applied:	2014 - 7.94 thousand person; 2015 - 9.8 thousand person
Any comments	Increase by 0.5% is foreseen for the next years

Data/Parameter # 9.7.6	**Amount of used water in Mtskheta Municipality daily/annually**
Data unit:	m^3
Description:	Measured primary data or secondary data calculated according to population
Source of data used:	During preparing SEAP data has been provided by Mtskheta Municipality and verified on http://geostat.ge that must be a main source.
Value applied:	2014 - 7.94 thousand person; 2015 - 9.8 thousand person
Any comments	Increase by 0.5% is foreseen for the next years

Data/Parameter # 9.7.7	**BOD (Bio-chemical use of Oxygen)**
Data unit:	kg
Description:	Primary data
Source of data used:	During preparing SEAP data has been gathered from IPCC methodology. Main source of information must be cleaner of used waters of Mtskheta.
Value applied:	18 250 kg
Any comments	There is no water cleaner in Mtskheta yet, but City Hall plans it.

Data/Parameter # 9.7.8	**Calculating of generated Methane**
Data unit:	m^3 or t
Description:	Secondary data. It must be calculated with IPCC methodology and responsible for it is monitoring group.
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl
Value applied:	Necessary parameters: • TOW – total amount of organic substance in discharged waters, BOD kg/yr • P – population (person) • BOD – indicator of BOD for country per capita, • I – correction coefficient I=1.25.
Any comments	Forecast of emissions from used water for 2016-2030 is based on an approach that the cleaner will be constructed and will start working in 2018. Full population of Mtskheta will be attached to it.

Monitoring of emissions reduction, resulting from measures implemented for used water cleaner

Activity #W2	**Emitted methane burning from used water cleaner building**
Planned implementation (dates)	**2018 -2030**
Description of activity:	Collecting and burning of emitted methane in rotch
Indicators, according to which the monitoring should be performed	Only basic indicators that must be monitored in case of implementation are given here • amount of gathered water in cleaning building (m^3/d); • size of BOD of incoming and emergent water (must be calculated by experimental method, g/m^3) • calculating amount of methane originated from slit with experimental method (m^3/h)
Amount of reduced emissions, got through the monitoring period	In case of project implementation 28.68 gg CO_2 will be saved in 13 years (2018-2030)
Comments	2 approaches are made in calculations: • gathering of only 80% methane is possible technically • after burning 1 t of methane, emission is 2.75 t CO_2
Implementing body/unit	Presumably, measure will be implemented by Mtskheta Municipality, after construction of water cleaner.

10 Sustainable Development Criteria

Monitoring reports should also include the results of observations on sustainable development criteria/indicators, as listed in general:

- Local capacity building of Mtskheta Municipality (staff, plans);
- Increase in population's quality of life and energy expenditure savings (per capita hot water consumption, expansion of heated areas/space, approximations of per area energy consumption to European standards, etc.);
- Promotion of residential condominiums creation;
- Improved comfort and energy savings in municipal/commercial buildings (heat, electricity, hot water consumption per area unit);
- Introduction of modern waste recycling technologies;
- Expansion of per capita green areas;
- Reduction of local pollutants (mainly due to measures taken in the transport sector);
- Increased number of jobs;
- Better gender equity;
- Demonstration and piloting new technologies;
- Promoting private sector development;

Municipalities are able to report on additional criteria that were influenced by measures carried out within the SEAP framework, as well as on main barriers hampering the plan implementation, plans in place to avoid and overcome main obstacles, and steps towards achieving success.

11 Annex I

Methodology and coefficients for calculation of baseline emissions and BAU scenario

GHG emissions are calculated using a formula adapted for the Intergovernmental Panel on Climate Change (IPCC) methodology Tier 1 sectoral approach for the local level, which is based on actual fuel consumption data:

Carbon Dioxide emissions$_j$ (GgCO2) =
$\square\square_i$ {Actual fuel consumption ji (unit) x caloric value of fuel i(MW.h36/per unit)
x carbon emissions factor (TC/MW.h)/1 000 x oxidized carbon portion i} x 44/12,
Where lower index refers to sector and lower index i - type of fuel.

Emissions for other gases with sector approach were calculated via following formula:
GHG emissions (GgGas) =
$\square\square$i {Actual fuel consumption ji (unit)
x caloric value of fuel(MWh/per unit)
x Gas emissions factor ji(TGas/MWh)/1 000].

The IPCC typical values of carbon emission factors (carbon emission per energy unit) and transfer coefficient (fuel's heat of combustion, i.e. caloricity) have been considered for calculations since 1996.

Table 67. Transfer Coefficients and Carbon Emissions Factors for Different Types of Fuel

Type of Fuel	Unit	Transfer Coefficient (MW/h unit)	Carbon Emission Factor (Ton C/ MWh)
Gasoline	1 000 liters	0.00950	0.247
Diesel	1 000 tons	0.01070	0.267
Liquid Gas	1 000 tons	0.0132	0.227
Natural Gas	1 million m^3	0.00935	0.202
Firewood	1 000 m^3	0.00210	--

The average emissions factor from the electricity grid was applied in 2014, which was 0.104 kg CO_2/kWh. A small portion of carbon in fuel is not oxidized during combustion but most is oxidized later in the atmosphere. It is calculated that non-oxidized carbon is stored indefinitely. Typical values of oxidized carbon recommended by the IPCC and used for 2006-2011 inventory are given in Table 68.

[36] Basic energy unit in IPCC methodology is Terajoule, while in the SEAP methodology it is MW/h, that is why MW/h is used in the text

Table 68. Portion of Oxidized Carbon for Different Fuels

Fuel	Portion of Oxidized Carbon
Oil and Oil Products	0.990
Natural Gas	0.995

Different gas emissions factors for the transport sector are given below in Table 69.

Table 69. Methane and Nitrous Oxide Emission Factors for Transport Sectors (kg/MWh)

GHG	Gasoline	Diesel	Natural Gas
CH_4	0.072	0.018	0.180
N_2O	0.0020	0.0020	0.0004

Global warming potential values (GWP) of these gases for converting methane and nitrous oxide into carbon dioxide equivalent are presented in Table 70.

Table 70. Global Warming Potential of Methane and Nitrous Oxide

Gas	Life Expectancy, Years	100-year GWP
CH_4	12±3	21
N_2O	120	310

A guidance document[37] has been developed by the Joint Research Centre (JRC) for the MGCe Eastern Partnership member cities, according to which these cities are given a choice to determine mandatory reductions of emissions through three alternative approaches:

1. Reduction for full emissions of fixed base year;
2. Per capita emissions reduction for fixed year emissions;
3. Reduction by Business As Usual (BAU) scenario for prospective emissions of 2020.

The Mtskheta SEAP uses emissions reduction calculations for the BAU scenario. There are two options of scenario construction described by the guidance document:

1. The country can develop its own methodology, which will be evaluated by the JRC later;
2. The country may use national ratios indicated in the guidance document, developed for the Global Atmosphere Research (EDGAR) project CIRCE[38] employing an emissions

[37]HOW TO DEVELOP A SUSTAINABLE ENERGY ACTION PLAN (SEAP) IN THE EASTERN PARTNERSHIP AND CENTRAL ASIAN CITIES" — GUIDEBOOK, European Commission Joint Research Centre, Institute for Energy and Transport, Luxembourg: Publications Office of the European Union © European Union, 2013

database. The POLES (Prospective Outlook for the Long-term Energy Systems)[39] method has been used, and considers growth of energy consumption due to population and economic growth. According to the baseline year, the BAU scenario calculates the level of emissions for 2020 assuming that current trends of population, economy, technologies and human behavior will continue, and that no national measures will be taken towards a reduction of emissions[40].

For Mtskheta the second approach has been applied, i.e. JRC ratios, according to which the 2014 emissions will grow by 36% to the year of 2020.

Applying this method, an Excel-based software program, muni-EIPMP (municipal emissions' inventory, projection and mitigation measures planning), has been developed by the USAID funded "Enhancing Capacity for Low-Emission Development Strategies Clean Energy Program", which has been used for the creation of Mtskheta Municipality SEAP. Applying this program it is possible to produce the baseline scenario on the basis of JRC ratios as well as using any other national factors. Since at the time of Mtskheta SEAP the BAU national scenario has not been generated yet, the JRC coefficients were applied.

[38] U.M. Doering, G. Janssens-Maenhout, J.A. van Aardenne, V. Pagliari (2010), CIRCE report D.3.3.1, Climate Change and Impact Research in the Mediterranean Environment: Scenarios of Future Climate Change IES report 62957. - A. Pozzer, P. Zimmermann, U.M. Doering, J. van Aardenne, H. Tost, F. Dentener, G. Janssens- Maenhout, and J. Lelieveld, Effects of business-as-usual anthropogenic emissions on air quality, Atmos. Chem. Phys. Discuss., 12, 8617-8676, 2012, doi:10.5194/acpd-12-8617-2012

[39] Russ, P., Wiesenthal, T., van Regenmorter, D., Ciscar, J. C., 2007. Global Climate Policy Scenarios for 2030 and beyond. Analysis of GHG Emission Reduction Pathway Scenarios with the POLES and GEM-E3 models, JRC Reference report EUR 23032 EN. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1510

[40] JRC Report, "An approach with a Business-as- Usual scenario projection to 2020 for the Covenant of Mayors from the Eastern Partnership", 2012. http://edgar.jrc.ec.europa.eu/com/JRC-IES_CoM-East_report_BAUprojections2.pdf

12 Annex II

Methodology for energy audit

An energy audit of typical buildings in Mtskheta was conducted using "Key Numbers" of the ENSI software. A Norwegian Consulting Company—ENSI--founded in 1992, developed simple software called "Key Number" for a quick calculation of energy characteristics that can be applied both for projecting rates for new buildings and reconstruction activities and for assessing energy-saving measures for existing buildings. Key figures reflect model values of specific types of energy consumption, taking into account all factors. Comparing measured and calculated values of energy consumption with key numbers permits a rapid assessment of energy efficiency and energy saving potential.

Today the actual exploitation conditions of buildings in Georgia differ substantially from designed/normative conditions. Thus, measured energy consumption may be higher than the one calculated e.g. due to water leakage or improper operation of a heating system; or lower, e.g. due to heating or ventilation system shutoffs. Additionally, along with energy-saving measures, an owner might need to improve the microclimate in the building by installing a forced air ventilation system or improving the existing system. All these will lead to an increase in energy consumption.

Due to the fact that in most cases "measured energy consumption" does not coincide with "estimated energy consumption", for getting the correct value of energy savings the calculated values of energy consumption should be used as a "baseline scenario", which describes the building's energy consumption under the comfort conditions.

In order to assess the energy consumption and relevant emissions three different scenarios (E_1=E_2=E_3) could be used: E_1- to get statistical data on energy (power, NG, wood,etc) consumption by building sector from energy providers; E_2- to calculate specific consumption of energy per sq. meter of building based on the results of energy audits and applied the data to other buildings. E_3- to calculate per capita energy consumption based on the results of building audit or surveys and multiply it by city population. Finally, cross comparison of these three scenarios makes it possible to determine the accuracy of calculation for each scenario (E1 = E2 = E3).

According to the **first scenario (E_1)**, it is possible to estimate an annual energy consumption on the basis of annual statistical data of consumed natural gas, electricity and firewood obtained from providers. Usually data on consumption are provided in standard units (kWh/yr, m^3, l, etc) and should be converted to kWh in order to compare, sum up or do any other mathematical operations (E1, kWh/yr).

The **second scenario (E_2)** needs a detailed energy audit of different types of pre-selected "typical" buildings and an estimation of specific energy expenditures (energy consumption per m^2, kWh/m^2yr) on heating, cooking and electricity use by various appliances. An energy audit carried out using ENSI software would allow us along to the assessment of energy consumption to determine the actual potential of energy-savings, involves a situational analysis and other tools to reduce energy consumption and CO_2 emissions.

13 Annex III

Methodology for calculation of carbon stock and annual carbon accumulation in green sector

The calculation of carbon accumulated in Mtskheta Municiopalitygreen cover and its annual accretion was performed using the IPCC methodological Guidelines. The calculations were conducted for so called "Live biomass" (including the underground biomass). Carbon stocks in the green cover were calculated separately for joint canopy and fragmentary plants. The losses in biomass due to falling down and trimming are also considered in calculations. Namely, the following equations were used in computations:

1. Equation calculating carbon savings in live biomass (including the underground and above ground love biomass):

$$C_F = [V \bullet D \bullet BEF_2] \bullet (1+R) \bullet CF$$

Where

V is the wood volume, m^3/ha

D_ Absolutely dry wood volume weight, tons of dry mass/ m^3;

BEF_2- Coefficient of converting commercial wood stock into the total stock of above-ground woody plants to get above-ground live biomass.

R_ Ratio of the trunk of a tree to its root mass;

CF_ Carbon content in dry substance/ ton C/ton dry mass.

2. Equations system to calculate annual increment in carbon stocks of biomass based upon the biomass accretion – decrease method (see **Error! Reference source not found.**):

$$C_{F_{LB}} = (C_{F_G} - C_{F_L})$$

$$C_{F_G} = (A \bullet G_{TOTAL}) \bullet CF \qquad C_{F_L} = H \bullet D \bullet BEF_2 \bullet CF$$

$$G_{TOTAL} = G_W \bullet (1+R)$$

$$G_W = I_V \bullet D \bullet BEF_1$$

Fig. 16 System of equations to calculate carbon accretion in biomass

Where

$C_{F_{LB}}$ is annual increase in carbon stocks due to biomass accretion, t C/yr.;

C_{F_G} –annual increase in carbon stocks due to biomass accretion, t C/yr.;

C_{F_L} –annual decrease in carbon stocks due to biomass losses, t C/yr.;

A- area covered by wood/plants;

G_{TOTAL}-average annual rates of total biomass increment, tone of dry mass/ha/year;

CF- share of carbon in biomass, t C/ton of dry mass;

G_W- aboveground biomass increment, t day mass;

I_V- biomass average annual increment, m^3/ha/year;

D- Absolutely dry wood volume weight, tons of dry mass/ m^3;

BEF_1- coefficient for converting average annual increment into the total aboveground biomass;

R-Ratio of the trunk of a tree to its root mass;

H- amount of annually purveyed timber volume, m^3/yr.;;

BEF_2- biomass increment coefficient for converting commercial wood stock into the total stock of above-ground biomass (including rind/bark).

Using the above given equations the carbon stocks in perennial plants of Mtskheta green cover and the annual sequestration of carbon have been determined.
Concerning the values of some coefficients used in calculations, as the perennial arboreal plants in city green cover are represented both in joined canopy and in fragmentary forms, corresponding to both cases indexes were applied in computations.

In particular, for joint canopy plants, mainly occupying slopes of hills surrounding the city, the Mtskheta Forestry taxation materials were used, while for city greenery (represented mainly in the fragmentary form) the wood stocks and other data (average age 40 years) were taken from different reference sources relevant to dominant in the city kinds, such as Tables of growth rates and stocks41 , etc. As a result average value of index has been obtained, permitting the approximate assessment of wood stock at 1 ha of fragmentary greening (40 m3).

As it has been mentioned above, the perennial arboreal plants in the city 1 590 ha of green cover are represented both in joined canopy and in fragmentary forms, from which joint canopy groves are dominating mainly at 50 ha of state forest territories, and the remaining 1 540 ha are covered with fragmentary plantings. Therefore, emission factors, typical for both types of plantings were applied in computations. Here it should be mentioned as well that in Accretion Factor, used in calculations, the vegetation extension ratio due plantings, conducted in 2014-2015 has been taken into account. Ensuing from this, the Accretion Factor was adjusted towards the growth rate.

In particular, the data on average annual accretion and woody stocks were used from the taxation materials (see Table 71), while for the specific weight of the wood (D) the data on absolutely dry wood volume weight of the dominant species were taken from different reference sources. The values of other coefficients (BEF1, BEF2, Rand CF) were brought from the standard Tables of IPCC methodology, relevant to climate conditions of examined region.

[41] Mirashvili V., Kuparadze G. Forest Taxation Reference Book (in Georgian)

Table 71. Indexes used in calculations

Main indexes applied in calculations	Used value of indexes	
	Fragmentary plants	Joint canopy plants
V- Tree stock m3/ha[42]	40	70
I_V- Woody plants (trees) mean annual increment, m³ [43]	1.6	1.9
D - volume weight of totally dry wood, ton totally dry mass[44]	0.55	0.65
BEF_1- Coefficient for conversion of wood mean increment into total aboveground (including crown) mean increment [45]		1.15
BEF_2- Coefficient for conversion of commercial wood stock into the total stock of aboveground stock (including crown), for calculating aboveground living biomass.[46]		1.3
R - Ratio of root mass to trunk[47]		0.24
CF-carbon share in dry wood. [48]		0.5

The model has been developed under the project CASFOR II, which was financed by the European Commission programme INCO2. The project was additionally financed by the Ministry of Agriculture, Nature Management and Fishing of the Netherlands and the National Council on Science and Technology of Mexico (CONACYT).

The model CO2FIX V3.1 determines the amount of carbon accumulation in the nature using the called "Accounting Method" of carbon stock-taking. In particular, the model calculated changes in carbon stockpiles, taking place for the specific span in all carbon "reservoirs" existing in the forest. (The carbon "reservoir" is considered to be that part of the ecosystem where the accumulation of carbon is taking place – the living biomass, litter, organic soils and produced timber resources).

In the model CO2FIX V3.1 the calculations are performed for one year and one ha scale in existing 6 main modules:

- Biomass module;
- Soil module;

[42] "Land Use Planning „of Samegrelo Zemo-Svaneti Regional Department, 2008;

[43]Average taxation rates of Batumi wood and plants; Adjara Forest Inventory, 2004

"Global Wood Database" http:/datadryad.org; მახვილაძე ე. მერქანმცოდნეობა, თბილისი 1962; Боровников А.М., Уголев Б. Н., Справочник по древесине. «ЛеснаяПромышленность», Москва, 1989;

[45]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.10,http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf;

[46]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.10;

[47]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.8http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf;

[48]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003).

- Produce of timber resources module;
- Bioenergy modules;
- Financial module;
- Carbon credits accounting module (for CDM).

According to the model methodology, the carbon accumulation volume (CTt) in each (t) period is calculated as follows:

CTt = Cbt +Cst + Cpt (Mg C/ha), where

Cb_t - Total amount of carbon in underground and above-ground biomass of a plant (Mg C/ha);

Cs_t - Carbon stocks in organic soils (Mg C/ha);

Cp_t -Carbon stocks of woody products obtained from forestry works (Mg C/ha).

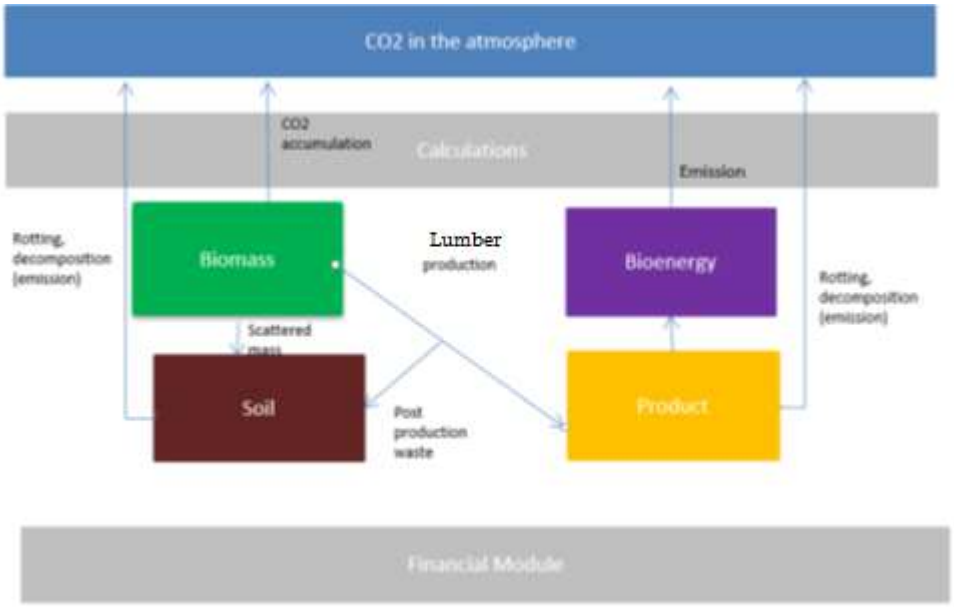

Fig. 17. Model Structure

Two counting modules – biomass and soil modules have been applied to calculate accumulation potential as a result of greening activities.

Biomass module: The biomass module uses a "Cohort System" for calculations. Cohorts comprise one or various groups of woody plants. Growth, drying and other features separately characterize each cohort species.

As an example the values of the main coefficients used in 2014 calculations are given in Table 72.

Table 72. Values of indexes used in the biomass module for the project scenario in Mtskheta

Indexes used in the Biomass Module	Value of the index
Carbon content	0.5 t.C /t.dry mass
Wood density, t.dry mass	
Maple	0.655
Pine	0.430
Georgian oak	0.660

Green ash	0.650
Cotinus	0.560
Sapindus	0.700
Paulownia	0.540
Initial carbon stocks	0tC/ha
Growth correction factor	1
Turnover rate of phytomass	
Coniferous:	
Needles	0.3
Branches	0.04
Roots	0.03
Deciduous:	
Leaves	1
Branches	0.05
Roots	0.08

Soil module:

The Yasso model is applied to determine carbon dynamics in soil. (http://www.efi.fi/projects/yasso/). The model (included into CO2FIX system) describes carbon decomposition and its dynamics in dry soil. It is calibrated for detection of total carbon stock in any soil layers. This model is suitable for coniferous, as well as for deciduous forests, and was tested in different countries with dissimilar climate zones to describe the influence of specific climate conditions on the decomposition process of the fallen leaves and branches.

Table 1. Indicators of accumulation of Carbon and absorption of Carbon Dioxide in 1 ha after greening

	Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...
year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...
1	3.58	13.11	20	51.56	189.06	39	91.39	335.10
2	6.10	22.38	21	53.92	197.69	40	93.19	341.69
3	8.67	31.77	22	56.25	206.24	41	94.96	348.19
4	11.23	41.19	23	58.55	214.70	42	96.71	354.59
5	13.80	50.61	24	60.84	223.08	43	98.43	360.90
6	16.38	60.07	25	63.10	231.38	44	100.12	367.12
7	18.97	69.54	26	65.33	239.55	45	101.79	373.25
8	21.55	79.02	27	67.52	247.59	46	103.44	379.30
9	24.13	88.49	28	69.68	255.50	47	105.08	385.28
10	26.72	97.96	29	71.81	263.30	48	106.69	391.18
11	29.28	107.38	30	73.90	270.98	49	108.28	397.01
12	31.84	116.74	31	75.96	278.54	50	109.85	402.78
13	34.38	126.04	32	78.00	285.99	51	111.40	408.48
14	36.90	135.30	33	80.00	293.32	52	112.94	414.11
15	39.41	144.50	34	81.97	300.55	53	114.46	419.68
16	41.89	153.61	35	83.91	307.68	54	115.96	425.19
17	44.35	162.61	36	85.83	314.70	55	117.45	430.64
18	46.78	171.52	37	87.71	321.60	56	118.92	436.03
19	49.18	180.34	38	89.56	328.40	57	120.37	441.37